Theory of vacuum

Alaya Kouki

Abstract

According to quantum mechanics the energy of a corpuscle in its fundamental state is not equal to zero because of the principle of uncertainty: there is always fluctuations due to exchanging energy with vacuum.

A corpuscle is considered as an harmonic oscillator exchanging energy with the exterior a quantity as an integer multiple of a certain amount of elementary energy which is the work of the friction force of the space-time from its rest state. The friction coefficient of space-time can be also considered as the mechanical impedance of vacuum.

The framework of this article is to lean on all those assumptions to unify natural interactions including gravity in one spherical potential. As a consequence of this unification, black holes and shooting stars can be classified as separately natural interactions.

Finally we propose an experience to determine the mechanical impedance of vacuum and we dress limits of nature referring to two absolute systems of unities: the Planck system and the new one.

1)The necessity of a friction coefficient of vacuum:

Let's have a reference of motion $R(O,x,y,z,t)$ .Let's have a corpuscle of a mass m in motion in this reference along the axis (O,x).The energy of this corpuscle considered as an harmonic oscillator according to wave mechanics of Schrodinger is [1]:

$$E_n = \left(n + \frac{1}{2}\right).\hbar.\omega_0 \quad (1)$$

Where :

$$\omega_0 = \sqrt{\frac{K}{m}} \qquad \text{(2):the frequency of the oscillator;}$$

K: the stiffness of the spring in which the corpuscle is attached;

This corpuscle have the potential:

$$V(x) = \frac{1}{2}.K.x^2 \qquad (3)$$

And in classical mechanics it have the energy:

$$E = \frac{1}{2}.K.{x_0}^2 \qquad (4)$$

Where :

x_0: the amplitude of vibration.

If $n = 0$ than from (1) we get:

$$E_0 = \frac{1}{2}.\hbar.\omega_0 \qquad (5)$$

The state of $n = 0$ correspond to the fundamental state or ground state where the corpuscle is in rest so according to the classical mechanics equation (3) we should have an energy equal to zero but we found according to quantum mechanics of Schrodinger an energy not equal to zero (equation (5)) so we deduce that the space-time is full with energy and has an impact on the motion of the corpuscle. So the equation of motion of the corpuscle is as follows:

$$\frac{d\boldsymbol{p}}{dt} = \boldsymbol{f} - a.\boldsymbol{v} \qquad (6)$$

Where $\boldsymbol{p}$**:** the momentum of the corpuscle;

a: the friction coefficient of the space-time(the vacuum);

$\boldsymbol{f}$: all unknown forces which act on the corpuscle;

$\boldsymbol{v} = \frac{d\boldsymbol{x}}{dt}$: the speed of the corpuscle;

$-a.\boldsymbol{v}$: an universal force due to the viscosity of space-time.

We will try to remove the contradiction between the classical mechanics and quantum mechanics: in a hand we have that the energy of the corpuscle is equal to zero and in the other hand its energy is not equal to zero.

Equation (6) can also be applied for a relativist corpuscle. The energy of such as corpuscle is:

$$E = \frac{m.c^2}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (7)$$

And so for a non relativist corpuscle equation (7) becomes:

$$E \approx m.c^2 + \frac{1}{2}.m.v^2 \quad (8)$$

From equation (5) and equation (8) we can expect that:

$$\frac{1}{2}.\hbar.\omega_0 = m.c^2 \qquad (9)$$

Let's return to our harmonic oscillator which is in rest. We can expect that according to the principle of uncertainty that the corpuscle can't be in rest [2]:

$$\Delta x.\Delta p \geq \hbar \qquad (10)$$

There is always a little vibration from the ''position of rest'' where the corpuscle exchange energy with vacuum. It is like that the corpuscle is under a vibratory force like follows:

$$\boldsymbol{f} = a.\boldsymbol{v} \qquad (11)$$

Where $''a''$:the mechanical impedance of vacuum. It is the same coefficient of friction due to viscosity of space-time.

2)The exchanging energy of the oscillator with vacuum :

The energy of the oscillator due to exchanging energy with vacuum is as follows:

$$\varepsilon = \int_0^{\frac{\pi}{2.\omega_0}} \boldsymbol{f}.d\boldsymbol{x} \qquad (12)$$

With :

$$x = x_0.\cos(\omega_0.t) \qquad \text{(13): Elongation of vibration}$$

$$v = \dot{x} = -x_0.\omega_0.\sin(\omega_0.t) \qquad \text{(14): the speed of the corpuscle}$$

$\frac{\pi}{2.\omega_0}$: Quarter of the period of vibration.

We choose the quarter of the period of vibration because we suppose that the oscillator take energy from vacuum in this quarter and loss it to vacuum in the second quarter...etc.

So we can have:

$$\varepsilon = \int_0^{\frac{\pi}{2.\omega_0}} a.v^2.dt = a.x_0^2.\omega_0^2.\int_0^{\frac{\pi}{2.\omega_0}} \sin^2(\omega_0.t)\,.dt \quad (15)$$

Let's change in equation (14) the variable $\theta = \omega_0.t$ so we have:

$$\varepsilon = a.x_0^2.\omega_0.\int_0^{\frac{\pi}{2}} \sin^2(\theta)\,.d\theta \quad (16)$$

We know that:

$$\int_0^{\frac{\pi}{2}} \sin^2(\theta)\,.d\theta = \frac{\pi}{4} \qquad (17)$$

So the exchanging energy is:

$$\varepsilon = a.x_0^2.\omega_0.\frac{\pi}{4} \qquad (18)$$

Replace x_0^2 as given by (4) and replace E as given by (1) we get :

$$\varepsilon_n = \frac{\pi}{2}.\hbar.a.\frac{\omega_0^2}{K}.(n+\frac{1}{2}) \qquad (19)$$

So the energy exchanged with the vacuum is not equal to zero.

4) Non relativist approximation of vacuum energy:

We generalize equation (6) for all corpuscles with:

$$\boldsymbol{p} = \frac{m.\boldsymbol{v}}{\sqrt{1-\frac{v^2}{c^2}}} \qquad \text{(20) : the momentum of the corpuscle}$$

It is evident that if $v \ll c$ we get from (6) :

$$m.\frac{d\boldsymbol{v}}{dt} = \boldsymbol{f} - a.\boldsymbol{v} \quad (21)$$

And if we neglect in (21) the vacuum force $'' - a.\boldsymbol{v}''$ than we get the Newton law of dynamics.

We define the inertia ξ of the corpuscle as:

$$\boldsymbol{p} = \xi.\boldsymbol{v} \qquad (22)$$

So from (20) we get:

$$\xi = \frac{m}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (23)$$

We define the inertial time$''\tau''$ of the corpuscle as:

$$\xi = a.\tau \qquad (24)$$

With the condition that:

$$d\tau = dt \qquad \text{(25):when the inertia is varying}$$

$$d\tau = 0 \qquad \text{(26):when the inertia is constant.}$$

We define the inertial time $''\tau_0''$ of the corpuscle in rest as:

$$m = a.\tau_0 \qquad (27)$$

From (23) and (24) we deduce the inertial time as a function of the speed of the corpuscle:

$$\tau = \frac{\tau_0}{\sqrt{1-\frac{v^2}{c^2}}} \quad (28)$$

Equation (25) is justified as follows: we can write the equation of motion (6) as the following:

$$\boldsymbol{f} = \frac{d^2(\xi.\boldsymbol{x})}{dt^2} \quad (29)$$

In equation (29) the inertia ξ is a function of time. This equation is a more generalized equation of motion because if inertia tends to the mass m of the corpuscle we get the classical law of dynamics.

Let's develop the equation (29):

$$\boldsymbol{f} = \ddot{\xi}.\boldsymbol{x} + 2.\dot{\xi}.\boldsymbol{v} + \xi.\ddot{x} \quad (30)$$

The equation of motion (30) should be independent from the choice of the origin of the reference of motion (principle of inertia or principle of objectivity) so we should have:

$$\ddot{\xi} = 0 \quad (31)$$

So:

$$\dot{\xi} = a \; (32)$$

Constant $''a''$ is declared as an universal constant.

Equation (30) can be written as follows:

$$\boldsymbol{f} - a.\boldsymbol{v} = \frac{d(\xi.\boldsymbol{v})}{dt} \quad (33)$$

Equation (33) is the same equation (6) if we take the inertia as (24) and the inertial time vary as (25) i.e the energy of the corpuscle is varying..

Equation (33) is the same equation (20) if the inertia is constant and tends to m.

We can write also equation (33) as follows:

$$a.\tau.\frac{d\boldsymbol{v}}{dt} = \boldsymbol{f} - 2.a.\boldsymbol{v} \quad (34)$$

And we have that:

$$lim(\frac{d\boldsymbol{v}}{dt})_{t\to+\infty} = lim(\frac{\boldsymbol{f}-2.a.\boldsymbol{v}}{a.\tau})_{\tau\to+\infty} = \boldsymbol{o} \quad (35)$$

So the speed of the corpuscle tends to a constant $''c''$ and this constant is declared as an universal constant: we know that it is the speed of light in vacuum.

Let's have another reference of motion $R'(O', x', y', z', t')$ in motion with a constant speed V related to the reference$R$. The corpuscle is in rest in the reference $'$. Axes (Ox) and $(O'x')$ are co-linear. The transformations of space and time between inertial references or Lorentz transformations are [3]:

$$x' = \frac{x - V.t}{\sqrt{1-\frac{V^2}{c^2}}} \qquad (36)$$

$$t' = \frac{t - x.V/c^2}{\sqrt{1-\frac{V^2}{c^2}}} \qquad (37)$$

It is very easy to get the transformations of the inertia and the momentum as follows:

$$\xi' = \frac{\xi - \boldsymbol{p}.\boldsymbol{V}/c^2}{\sqrt{1-\frac{V^2}{c^2}}} \qquad (38)$$

$$\boldsymbol{p}' = \frac{\boldsymbol{p} - \xi.\boldsymbol{V}}{\sqrt{1-\frac{V^2}{c^2}}} \qquad (39)$$

$\boldsymbol{p}'$ and ξ' are respectively the momentum and the inertia of the corpuscle according to the reference R'. There is always invariants in inertial references to conserve the same speed of light. We have here an invariant which is:

$$\xi^2 - (\frac{p}{c})^2 = m^2 \qquad (40)$$

The exchanging energy of the corpuscle with vacuum is :

$$\varepsilon = \int_0^{x_0.\omega_0} a.\boldsymbol{v}.d\boldsymbol{x} = \int_0^{x_0.\omega_0} a.v^2.d\tau \; (41)$$

In the non relativist case we have $v \ll c$ and so from (28) we deduce that:

$$\tau \approx \tau_0.(1 + \frac{1}{2}.\frac{v^2}{c^2}) \qquad (42)$$

So we have:

$$d\tau = \frac{\tau_0}{2.c^2}.dv^2 \qquad (43)$$

From (41) we deduce that:

$$\varepsilon = \int_0^{x_0.\omega_0} \frac{1}{2}.m.\frac{v^2}{c^2}.dv^2 = \int_0^{x_0.\omega_0} m.\frac{v^3}{c^2}.dv = \int_0^{x_0.\omega_0} \frac{1}{4}.\frac{m}{c^2}.dv^4 = \frac{1}{4}.\frac{m}{c^2}.x_0^4.\omega_0^4 \quad (44)$$

Replace x_0^2 by its expression in (4) we get:

$$\varepsilon = \frac{m}{c^2}.\frac{E^2}{K^2}.\omega_0^4 \qquad (45)$$

Replace E by its expression in (1) we get:

$$\varepsilon_n = \frac{m}{c^2.K^2}.(n + \frac{1}{2})^2.\hbar^2.\omega_0^6 \quad (46)$$

For $n = 0$ (the fundamental state) of the corpuscle we get:

$$\varepsilon_0 = \frac{m}{c^2.K^2}.\frac{1}{4}.\hbar^2.\omega_0^6 \qquad (47)$$

Replace K by its expression in (2) we get:

$$\varepsilon_0 = \frac{1}{4}.\frac{\hbar^2.\omega_0^2}{m.c^2} \quad (48)$$

The expression of ε_0 in (48) should be the same expression of E_0 in(5). So we get:

$$\frac{1}{2}.\hbar.\omega_0 = m.c^2 \; (49)$$

Equation (48) is the same equation in (5) so the idea of a mechanical impedance of vacuum which is the same coefficient of friction of space-time is justified.

3)Applications of the theory of vacuum:

3-1)Limit of the model of Bohr atom:

The first electron in a Bohr atom will be linked with an energy [4]:

$$E = -Z^2.R_\infty \quad (50)$$

Where Z: the atomic number of the model of Bohr atom.

$R_\infty = 13.6\ eV$: non relativist ionisation potential of the atom of hydrogen

Equation (4) should be equal to the equation (50) in absolute value:

$$\frac{1}{2}.K.{x_0}^2 = Z^2.R_\infty \quad (51)$$

Replace K by its expression in (2) and ω_0 by its expression in (49) we get:

$$x_0^2 = \frac{Z^2.\hbar^2.R_\infty}{2.m^3.c^4}$$ (52): the amplitude of vibration of the electron.

The maximum of the amplitude of vibration of the electron can't exceed the radius of the model of the Bohr atom :

$$x_0^2 \leq (\beta.a_0)^2 \quad (53)$$

Where a_0 : is the radius of circular orbit of the electron of the planetary model of the atom.

$0 < \beta < 1$: a coefficient to determine in order to cover the most atoms in Bohr model.

The condition of dynamic equilibrium of the electron imposed that:

$$m.\frac{v^2}{a_0} = Z.\frac{e^2}{a_0^2}$$ (54) (we use here the cgs system)

The condition of Bohr quantification is:

$$m.v.a_0 = \hbar \quad (55)$$

Replace in (54) the expression of v as given in (55) we get:

$$a_0 = \frac{\hbar^2}{Z.m.e^2} \quad (56)$$

Replace in (53) x_0^2 by its expression in (52) and a_0 by its expression in (56) we get:

$$Z \leq \left(\frac{2.\beta^2.\hbar^2.m.c^4}{e^4.R_\infty}\right)^{1/4} = \sqrt{\beta}.\left(\frac{2.\hbar^2.m.c^4}{e^4.R_\infty}\right)^{1/4} \quad (57)$$

With: $\hbar = 1.054\ 10^{-27}\ erg.s$: Planck constant

$m = 9.109\ 10^{-28}\ g$: the mass of the electron

$e = 4.809\ 10^{-10}\ ues$: the electric charge of the electron

$c = 2.997\ \ 10^{10}\ cm/s$: the speed of light in vacuum

$1\ eV = 1.602\ \ 10^{-12}\ erg$: conversion unit

From (57) we get:

$$Z \leq \sqrt{\beta}.193 \quad (58)$$

We hope that Z can reach 90 to cover the most of the chemical atoms, so we have:

$$\beta = 0.21 \quad (59)$$

3-2)The stiffness of the electron in the Bohr model of the atom:

In its fundamental state the energy exchanged with vacuum for the electron is deduced from (19):

$$\varepsilon_0 = \frac{1}{4}.\pi.\hbar.a.\frac{\omega_0^2}{K} \quad (60)$$

Replace ω_0 by its expression in (2) and do that equation (60) is equal to equation (5) we get:

$$K = \frac{\pi^2.a^2}{4.m} \quad (61)$$

(61) is the stiffness of the electron-oscillator in the model of Bohr atom. In this model the electron is oscillate around its position at the Bohr radius a_0 with an amplitude x_0 .

3-3)Expansion of the Universe:

Let's have two bodies with masses M and m .Body with mass M is in the centre O and the other body with mass m is in position A under the universal attraction of Newtonian gravitation.

We have :

$$m.\frac{d\vec{v}}{dt} = -\frac{G.m.M}{r^2}.\vec{u}_r - a.\vec{v} \quad (62)$$

We use the polar coordinates (r, θ) instead of Cartesian coordinates (O, x, y, z) the motion is happening in the plan (O, x, y).

G: is the gravitational constant.

The speed of the body m is:

$$\vec{v} = \dot{r}.\vec{u}_r + r.\dot{\theta}.\vec{u}_\theta \quad (63)$$

Its cinematic moment is:

$$\vec{L} = \overrightarrow{OA} \wedge (m.\vec{v}) \quad (64)$$

Its acceleration is :

$$\frac{d\vec{v}}{dt} = \left(\ddot{r} - r.\dot{\theta}^2\right).\vec{u}_r + \left(2.\dot{r}.\dot{\theta} + r.\ddot{\theta}\right).\vec{u}_\theta \quad (65)$$

It is very easy to get:

$$\frac{d\vec{L}}{dt} = -a.r^2.\dot{\theta}.\vec{k} \quad (66)$$

With: $\vec{k} = \vec{u}_r \wedge \vec{u}_\theta$ (67)

Equation (66) signify that motion is happened in a plan.

It is very easy to get from (62) the following equations:

$$m.\left(\ddot{r} - r.\dot{\theta}^2\right) = -\frac{G.m.M}{r^2} - a.\dot{r} \quad (68)$$

$$m.\left(2.\dot{r}.\dot{\theta} + r.\ddot{\theta}\right) = -a.r.\dot{\theta} \quad (69)$$

The integration of equation (69) gives us:

$$r^2.\dot{\theta} = 2.K_c.\exp(-\frac{a}{m}.t) \quad (70)$$

Where K_c is a constant (Kepler constant).

It is very easy to deduce that the system will collapse: the only solution to avoid this catastrophe is that the Universe should be in expansion in minimum with a speed to compensate the retracting speed. It is very important to note that the time $\frac{m}{a}$ could be equal to the age of the Universe for example because we don't know now the value of constant $''a''$.

3-4)An absolute system of unities:

A system of unities when $\hbar = c = a = 1$ is very different from the Planck system in which we have $\hbar = c = G = 1$ with G is the gravitational constant. Constant G is simply the coupling constant for the gravitational interaction and tell us how much is strong this interaction.

If we take M the unit of measuring mass, $L$the unit of measuring length and T the unit of measuring time it is very easy to deduce that our system is as the following :

$$M = \frac{1}{c}.\sqrt{\hbar.a} \quad (71) \quad , \quad L = \sqrt{\frac{\hbar}{a}} \quad (72) \quad , \quad T = \frac{1}{c}.\sqrt{\frac{\hbar}{a}} \quad (73)$$

In the cgs system we should expect that constant $''a''$ should have very low value.

4)Photons:

Photons are less mass corpuscles .They are also packets of train of electromagnetic waves. Their speed is equal to the speed of light in vacuum $''c''$.

A photon have a frequency ω an inertia ξ and a proper time τ as the following:

$$E = \hbar.\omega = \xi.c^2 = \alpha_0.\tau \quad (74)$$

With E: is the energy of the photon;

α_0: is an universal constant;

$d\tau = dt$: if the energy of the photon is varying

Let's have a train of packets of electromagnetic waves with a frequency quasi-monochromatic ω. The uncertainty of the energy of the photon which is the train of a packet of electromagnetic waves is:

$$\Delta E = \hbar.\Delta\omega = \alpha_0.\Delta\tau \quad (75)$$

With: $\omega = \omega_0 \pm \Delta\omega$ (76): the frequency of the train of packets of electromagnetic waves

$\Delta\tau = \frac{1}{\Delta\omega}$ (76): lifetime of excite state of the source of waves [4]

It is very easy to deduce from (75) and (76) that:

$$\Delta\omega = \sqrt{\frac{\alpha_0}{\hbar}}$$ (77): the minimum of the frequency to speak about a photon.

The maximum length of a train of packet of electromagnetic waves is:

$$\Delta l = c.\Delta\tau = c.\sqrt{\frac{\hbar}{\alpha_0}} \quad (78)$$

And the energy minimum to speak about a photon is:

$$\Delta E = \sqrt{\hbar.\alpha_0} \quad (79)$$

The energy (79) is equivalent to a unit of measuring masses as:

$$M = \frac{\sqrt{\hbar.\alpha_0}}{c^2} \quad (80)$$

From equations (24) and (74) it is very easy to deduce that:

$$\alpha_0 = a.c^2 \quad (81)$$

In the motion of the photon there is many cuttings i.e. the train of packets of electromagnetic waves is absorbed by vacuum and it appears again in a continuously manner along the direction of propagation. It is like that the photon is maintained as a classic swing with a force:

$$f = a.c \quad (82)$$

Of course if we replace in (76), (78) , (80) constant α_0 with its expression in (81) we get the absolute system of unities (71), (72), (73).

5)Wave-corpuscle duality and viscosity-dispersion duality:

De Broglie had considered a corpuscle as a packet of plane matter waves which are reinforced around the position of the corpuscle $(\boldsymbol{x}, t)$ and annihilate themselves above. The wave function associated to the corpuscle is:

$$\psi(\boldsymbol{x}, t) = A.\exp(i\boldsymbol{k}.\boldsymbol{x} - i\omega.t) \quad (83)$$

Where:

A: the amplitude of the wave function

$\hbar.\boldsymbol{k} = \boldsymbol{p} = \frac{m.v}{\sqrt{1-\frac{v^2}{c^2}}}$ (84) : the relationship between the wave vector and the momentum.

$\hbar.\omega = \xi.c^2 = \alpha_0.\tau = \frac{m.c^2}{\sqrt{1-\frac{v^2}{c^2}}}$ (85): the relationship between the frequency and the inertia .

The wave function associated to the corpuscle has a quasi-monochromatic frequency ω and a wave vector k verifying the principle of uncertainty as follows:

$$\Delta k.\Delta x \geq 1 \quad (86)$$

$$\Delta\omega.\Delta t \geq 1 \quad (87)$$

The group speed v_g of the packet of waves is the speed with which the energy is transmitted .Its definition is as follows:

$$\frac{1}{v_g} = \frac{dk}{d\omega} \quad (88)$$

It is very easy to verify that:

$$v_g = v \quad (89)$$

The phase of the wave function is an invariant by Lorentz transformations of space and time between inertial references. It is very easy to verify that we have:

$$x.k - \omega.t = x'.k' - \omega'.t' \quad (90)$$

Where k' and ω' are the wave vector and the frequency associated to the corpuscle in rest in a referential $R'(O', x', y', z', t')$ with:

$$k' = 0 \quad (91) \text{ as deduced from } (84)$$

$$\omega' = \frac{m.c^2}{\hbar} \quad (92) \text{ as deduced from } (85)$$

The equation of propagation of the wave function (Klein-Gordon equation) is:

$$\frac{1}{c^2}.\frac{\partial^2}{\partial t^2}\psi(\boldsymbol{x}, t) - \nabla^2\psi(\boldsymbol{x}, t) = -\frac{m^2 c^2}{\hbar^2}\psi(\boldsymbol{x}, t) \quad (93)$$

We define the following operator called also d'Alembertian:

$$\Box \equiv \frac{1}{c^2}.\frac{\partial^2}{\partial t^2} - \nabla^2 \quad (94)$$

Equation (93) can be written also as the following:

$$\Box\psi(\boldsymbol{x}, t) = -\frac{m^2 c^2}{\hbar^2}\psi(\boldsymbol{x}, t) \qquad (95)$$

The d'Alembertian of the wave function is not equal to zero so there is dispersion of the wave function. The medium in which the packet of waves is in propagation is a dispersive medium: there is attenuation of the packet of waves with absorption of energy.

A dispersive medium for waves correspond for corpuscles to a viscous medium. The equation of motion of the corpuscle is:

$$\frac{d\boldsymbol{p}}{dt} = \boldsymbol{f} - a.\boldsymbol{v} \quad (96)$$

Where:

$\boldsymbol{f}$: all unknown forces which act on the corpuscle;

$-a.\boldsymbol{v}$: an universal friction force which act on the opposite side of motion of the corpuscle;

a : friction coefficient of the space-time (or mechanical impedance of vacuum).

So we can conclude that for wave-corpuscle duality there is another duality which is viscosity-dispersion duality of space-time .

Let's remark that we can put the wave function (83) as follows:

$$\varphi(x, t) = A.\exp(iK.x - i\omega.t) \quad (97)$$

With: $\hbar.K = P = \xi.c$ (98)

And we have:

$$\Box\varphi(x,t) = 0 \quad (99)$$

We will conclude that there is no dispersion but it is wrong because we haven't the invariance of phase for the wave function by Lorentz transformations of space and time:

$$x.K - \omega.t \neq x'.K' - \omega'.t' \ (100)$$

From (92) we remark that the frequency associated to a relativist corpuscle in rest is :

$$\hbar.\omega_0 = m.c^2 \quad (101)$$

A corpuscle in rest is a non relativist corpuscle so from (49) and (101) we conclude that the second half of $\hbar.\omega_0$ is yield to vacuum. The total energy of the corpuscle is break down between the corpuscle and vacuum. We can model the vacuum as an infinite of harmonic oscillators exchanging energy with real corpuscles. If there is no corpuscles there is virtual oscillators for vacuum exchanging nothing.

6**)Exchanging energy with vacuum for a relativist corpuscle:**

Let's have a corpuscle in rest in the referential $R(O,x,y,z,t)$. This corpuscle can't be in rest because of the principle of uncertainty so there is exchanging energy with vacuum. This corpuscle is an infinite superposition of plane waves around the position $(\boldsymbol{x},t)$ of the corpuscle .

The exchanging energy with vacuum is the work of the friction force:

$$\varepsilon = \int_{\tau_0}^{\tau} a.\boldsymbol{v}.d\boldsymbol{x} = \int_{\tau_0}^{\tau} a.v^2.dt = \int_{\tau_0}^{\tau} a.c^2.\left(1-\frac{\tau_0^2}{t^2}\right).dt = a.c^2.\tau.(1-\frac{\tau_0}{\tau})^2 \quad (102)$$

In the interval $(x \pm \Delta x, t \pm \Delta t)$ the corpuscle is a superposition of many monochromatic waves at every point of this interval and also above. If we choose a certain discernible number of positions in this interval we can accept that the exchanging energy with vacuum is approximately :

$$\varepsilon_n = n.\varepsilon = n.a.c^2.\tau.(1-\frac{\tau_0}{\tau})^2 = n.\xi.c^2.(1-\frac{m}{\xi})^2 \quad (103)$$

Where n : is an integer which can be positive or negative (the corpuscle can take energy from vacuum or loose energy for vacuum).

With the condition that $\varepsilon_n \to 0$ when $n \to \pm\infty$: the total energy of the corpuscle should be finite.

The total energy of the corpuscle is:

$$E = \xi . c^2 + \varepsilon_n = \xi . c^2 + n . \xi . c^2 . (1 - \frac{m}{\xi})^2 \quad (104)$$

With the condition that $\xi \to m$ when $n \to \pm\infty$ (the momentum is very well defined and it tends to zero but the position is bad defined).

This image is that the corpuscle is like an harmonic oscillator maintained in oscillation by a force $\boldsymbol{f} = a.\boldsymbol{v}$ where $''a''$ is a coefficient of a mechanical impedance.

7)Unification of natural interactions:

What interactions can have the corpuscle with the other corpuscles or fields?. We choose a system of unities where $\hbar = c = a = 1$ to facilitate the writing of equations.

A corpuscle with a certain energy in equation (104) can be a source of potential $V(r)$ or represent a field potential which verify the Klein-Gordon equation. The potential $V(r)$ has a spherical symmetry and is independent from time . The corpuscle haven't any intrinsic angular momentum.

Klein-Gordon equation (93) can be written as the following:

$$\nabla^2 \psi(x,t) = -(m^2 - \omega^2)\psi(x,t) \quad (105)$$

In spherical coordinates the potential which can be generated by the corpuscle verify equation (105):

$$\nabla^2 V(r) = -(m^2 - \omega^2).V(r) \quad (106)$$

The ''stability '' of a system is happened when its energy is in the minimum. For our corpuscle this is possible when $\frac{dE}{d\xi} = 0$ and so from (104) and (74) we obtain that:

$$\xi^2 = m^2 . \frac{n}{n+1} = \omega^2 \quad (107)$$

Replace in (106) ω^2 by its expression in (107) we get:

$$\nabla^2 V(r) = -\frac{m^2}{n+1}.V(r) \quad (108)$$

In spherical coordinates we have $\nabla^2 \mathrm{V(r)} = \frac{1}{\mathrm{r}}.\frac{\mathrm{d}}{\mathrm{dr}}\left(\mathrm{r}^2.\frac{\mathrm{dV}}{\mathrm{dr}}\right)$ and so we deduce from (108) that :

$$V(r) = \frac{K}{r}.\exp(\frac{-m.r}{\sqrt{n+1}}) \quad (109) \qquad \text{or} \quad V(r) = \frac{K\prime}{r}.\exp(\frac{m.r}{\sqrt{n+1}}) \quad (110)$$

With K and K' are constants.

In general we are dealing with attractive potential.

From equation (109) of the potential we conclude that:

*for $n = 0$ the potential (109) correspond to the nuclear potential;

*for $n \to +\infty$ the potential (109) correspond to the gravitational potential;

*for $n = -1$ the potential (109) and (110) are not defined. There is a singularity. There are limits when n reach -1 from the positive side or the negative side i.e :

-When $n \to -1^{+}$ relationship (109) becomes strongly attractive: it corresponds to black hole interaction ;

-When $n \to -1^{+}$ relationship (110) becomes strongly repulsive: it corresponds to shooting star phenomenon;

*for $n < -1$ relationship (109) correspond to radioactivity: there is propagation of matter.

8)Negative mass:

We think that gravitation is happened only with positive masses present in the Universe but also negative masses can be present and create gravitation interaction with all types of masses. We can notice that for a system with an energy E a quantum level n and an inertia ξ formulae (104) can be resolved as an equation of the secondary order when $''m''$ is the unknown parameter and so we can get two solutions for mass one is positive designate by $''m_{(+)}''$ and the other is negative designate by $''m_{(-)}''$.

Equation (104) can be easily written as follows:

$$n.c^2.m^2 - 2.n.\xi.c^2.m + (n+1).\xi^2.c^2 - \xi.E = 0 \quad (111)$$

So the determinant Δ of this equation is:

$$\Delta = 4.n.c^2.\xi.(E - \xi.c^2) \quad (112)$$

And so we get as solutions of equation (111):

$$m_{(+)} = \frac{2.n.\xi.c^2 + \sqrt{\Delta}}{2.n.c^2} \quad (113)$$

$$m_{(-)} = \frac{2.n.\xi.c^2 - \sqrt{\Delta}}{2.n.c^2} \quad (114)$$

With the condition that $E > (n+1).\xi.c^2$ and $n > 0$ or $E < (n+1).\xi.c^2$ and $n < 0$. Otherwise we will get imaginary masses.

Negative gravitation is repulsive and is due to negative mass associated to galaxies. This is known as dark energy or dark mass which correspond to dissipation of energy.

Similar analyse can be done for the inertia ξ as the unknown parameter in the equation (111): we will get others conclusions.

9)An experience to determine the constant $''a''$:

We propose the experience of the photo-electric effect to determine the constant $''a''$. In this experience there is a photo-electric cell , a voltmeter to measure the tension V applied by a generator on its terminals , a galvanometer to measure the current I and of course a source of monochromatic light with a frequency ν .

We assimilate the photo-electric cell as a capacitor with a capacity C_0.

Let's irradiate the photo-electric cell with the maximum of intensity of the light and varying the tension V until the current I reach the maximum.

The kinetic energy of one electron is :

$$\frac{1}{2}.m.v^2 = E - W \quad (115)$$

Where E: energy provided by light

W:work to extract one electron from the metal

If :

$$e.V \geq \frac{1}{2}.m.v^2 \quad (116)$$

So V is the potential which stop the electrons to reach the negative charged electrode.

If:

$$e.V \leq \frac{1}{2}.m.v^2 \quad (117)$$

Than the electrons will reach the negative charged electrode and there is a current in the circuit.

v: is the speed of the ejected electrons.

m:the mass of the electron

e: the electric charge of the electron.

Now we are in the point when the current reach at the first time its maximum. It is possible that there is no need for a generator: we put the cell in short circuit with a resistor and we irradiate it with a monochromatic light until the current I reach its maximum and also the tension V reach its maximum by varying the intensity of the incident light. Of course the galvanometer is in serial with the cell.

Every electron which reach the collection electrode will create a potential difference $\frac{e}{C_0}$.

For N electrons we get a potential difference V as the following:

$$V = \frac{N.e}{C_0} \quad (118)$$

Let's have:

ΔN : the number of electrons which travel between the two electrodes during an interval of time Δt. So ΔN is equal to the quantity of energy provided to the electrons during this interval of time divided by the required energy for one electron to do the travel between the electrodes:

$$\Delta N = \frac{P.\Delta t - W.\Delta N}{e.V} \quad (119)$$

Where P: the energy supplied by the incident light to the electrode per unit of time (i.e the power).

For an infinitely small Δt we get:

$$\frac{dN}{dt} = \frac{P}{e.V + W} \qquad (120)$$

Replace V by (117) and integrate (119) with $N = 0$ when $t = 0$ so we get:

$$W.N + \frac{e^2.N^2}{2.C_0} = P.t \quad (121)$$

For a photon we have:

$$E = h.\nu = a.c^2.\tau \ (122)$$

So the time to lose this energy is :

$$t = \tau \qquad (123)$$

And the absorbed power is:

$$P = N.a.c^2 \quad (124)$$

From (121) we can deduce that:

$$N = \frac{2.\hbar.C_0}{e^2}.\nu - \frac{2.W.C_0}{e^2} \quad (125)$$

The power furnished by light is equal to the power in the circuit plus the power to extract the electrons from the metal of the electrode, so we have:

$$V.I = N.a.c^2 - P_0 \quad (126)$$

Where P_0 : the necessary power to extract the electrons (a characteristic of the metal of the cell) .

Replace N by (125) we get:

$$V.I = \frac{2.\hbar.C_0.a.c^2}{e^2}.\nu - K_0 \quad (127)$$

Where K_0: is a constant which depends on the characteristics of the photo-electric cell.

The power in the circuit is a linear function of the frequency of incident light. The coefficient of linearity contains the constant $''a''$ and so we can determinate it.

10)The limits of nature:

The Planck system of unities is an absolute system where $\hbar = c = G = 1$.

If we take M_P the unit of measuring mass, L_P the unit of measuring length and T_P the unit of measuring time it is very easy to deduce that our system is as the following :

$$M_P = \sqrt{\frac{\hbar.c}{G}} = 2.18 \;\; 10^{-8} \, Kg \quad (128) \;,$$

$$L_P = \sqrt{\frac{\hbar.G}{c^3}} = 1.6 \;\; 10^{-35} \, m \qquad (129) \;,$$

$$T_P = \sqrt{\frac{\hbar.G}{c^5}} = 5.39 \;\; 10^{-44} \, s \qquad (130).$$

This system is applicable for Planck until the laws of gravity and thermodynamics still available and the speed of light in vacuum still the same.

*For quantum mechanics there is a minimum of action which is the Planck constant $\hbar$.

*For Restraint Relativity –where Lorentz transformations are applicable -there is a maximum of speed which is c.

*For General Relativity –where there is equivalence between gravity and any field of acceleration-there is a maximum of force which is $\frac{c^4}{4.G}$ [5].

-The maximum of power is : $P_{max} = \eta = \frac{c^5}{4.G}$ (131)

-The annihilation of a black hole of a mass M takes the time: $T_{ann} = \frac{2.R_g}{c} = \frac{4.M.G}{c^3}$ (132)

With $R_g = \frac{2.G.M}{c^2}$ the gravitational radius.

-The realised power is: $P = \frac{M.c^2}{T_{ann}} = \frac{c^5}{4.G} = \eta$ (133)

*For classical mechanics:

-Newton force of gravitation between two planets of masses M_1 & M_2 is:

$$F = \frac{G.M_1.M_2}{R^2} = \left(\frac{G.M_1}{c^2.R}\right).\left(\frac{G.M_2}{c^2.R}\right).\frac{c^4}{G} \quad (134)$$

We have always $M_1.M_2 \leq \frac{1}{4}.(M_1 + M_2)^2$ so:

$$F \leq [\frac{(M_1+M_2).G}{c^2.R}]^2.\frac{c^4}{4.G} \quad (135)$$

The bringing of the planets together is limited to the condition that $R > R_g$ with $R_g = \frac{2.M.G}{c^2}$ to avoid a black hole formation of a mass $M_1 + M_2$ so :

$$F \leq \frac{c^4}{4.G} \quad (136)$$

If we use the notion of power limit (133) we get the new Planck system of unities:

$$M_P = \sqrt{\frac{\hbar.\eta}{c^4}} \quad (137), \qquad L_P = \sqrt{\frac{\hbar}{\eta}}.c \quad (138), \qquad T_P = \sqrt{\frac{\hbar}{\eta}} \quad (139)$$

From (139) the Planck time is defined with two fundamental constants $\hbar$ and η i.e if we change c and G in a manner that η remains unchanged so the Planck time doesn't change . On the other side the Planck mass and the Planck length changes.

$$lim_{c\to+\infty} R_g = lim_{c\to+\infty} \frac{2.m.G}{c^2} = 0 \quad (140)$$

$lim_{P_{max\to+\infty}} = lim_{c\to+\infty} \frac{2.m.c^3}{P_{max}} = 0$ (141)

i.e when $\eta \to \infty$ and $c \to \infty$ the concept of gravitational radius and the event horizon becomes meaningless. The existence of event horizon is finiteness to the realised power at the speed of light.

*We conclude the limits in the Universe as:

10-1) Forces in nature:

*The minimum of force (for a string in vacuum) is : $F_{min} = a.c$

*The maximum of force is : $F_{max} = \frac{c^4}{4.G}$

10-2) Lengths in nature:

*The gravitational radius is: $R_g = \frac{2.G.m}{c^2}$

*The inertial length of a corpuscle in rest is: $l_0 = \frac{m.c}{a}$

*The Compton wave length is: $\frac{\hbar}{m.c}$

*The minimum length in space-time (the radius of the earliest Universe) is: $L_{min} = L_P = \sqrt{\frac{\hbar.G}{c^3}} = \sqrt{\frac{\hbar}{\eta}}.c$

*The maximum length in space-time (the maximum radius reach by the Universe) is: $L_{max} = \sqrt{\frac{\hbar}{a}} = c.\sqrt{\frac{\hbar}{\alpha_0}}$

10-3) Powers in nature:

*The maximum power is: $\eta = \frac{c^5}{4.G}$

*The minimum power is : $\alpha_0 = a.c^2$

10-4) Densities in nature:

*The minimum line density of a space-time string (vacuum) is: $\frac{a}{c} = \frac{\alpha_0}{c^3}$

*The maximum line density of space-time string is : $\frac{c^2}{G} = \frac{4.\eta}{c^3}$

*The maximum of volume density (in the earliest Universe) is: $\rho_{PL} = \frac{c^5}{G^2.\hbar}$ [6]

*The minimum of volume density in space-time (vacuum) is: $\rho_0 = \frac{a^2}{\hbar.c}$

10-5) Mechanical impedance in nature:

*The minimum of mechanical impedance of space-time (vacuum) is: $a = \frac{\alpha_0}{c^2}$

*The maximum of mechanical impedance of space-time (in the earliest Universe) is: $\frac{c^3}{G} = \frac{4.\eta}{c^2}$

10-6) Accelerations in nature:

*The minimum of acceleration is: $c^2.\sqrt{\frac{a}{\hbar}} = c.\sqrt{\frac{\alpha_0}{\hbar}}$

*The maximum of acceleration is: $\sqrt{\frac{\eta}{\hbar}}.c$ [7]

10-7)Times in nature:

*The minimum time is: $T_{min} = T_P = \sqrt{\frac{\hbar.G}{c^5}} = \sqrt{\frac{\hbar}{\eta}}$

*The maximum time (the lifetime of the Universe) is: $T_{max} = \frac{1}{c}.\sqrt{\frac{\hbar}{a}} = \sqrt{\frac{\hbar}{\alpha_0}}$

11)Conclusion:

We conclude that to unify gravitation and quantum mechanics we should consider vacuum as a fluid with a mechanical impedance. This constant-the mechanical impedance- is declared as an universal constant. Space-time is not only a theatre of interactions between corpuscles, it participates and act on them. We get a new system of unities which combined with Planck system we dress limits in power, force, densities, acceleration…in nature. To confirm our assumptions, we propose an experience to get a value of the ''friction coefficient of universe''. There is another experience which with it we can determine the constant $''a''$: it is the black body radiation and it is not described in this paper. Gravitation is happened without any exchange of energy: it is a limit interaction.

For vacuum it is defined an electrical impedance which is equal to $377\ \Omega$ and it is the ratio of the electrical field on the magnetic field of an electromagnetic plane wave: it is not a real resistance. For the same reasons we can associate to vacuum a mechanical impedance which tell us that we can't transfer power instantaneously: there is always a delay time to absorb/emit energy.

References:

[1]Allan Adams ''Lecture 8 :Quantum harmonic oscillator'' MIT OpenCourseWare 2013.

[2]H.BOUCHRIHA ''Introduction à la physique quantique'', Centre de publication universitaire 2002,Chap.5, p.128.

[3]L.Landau, E.Lifchitz ''Physique théorique'' ,(MIR,MOSCOW 1989),Vol.2,Chap.1, p.18.

[4]E.H.Wichmann ''BERKLEY cours de physique'', (ARMAND-COLIN, PARIS 1981),Vol.4,Chap.3, p.109.

[5] Yu.L.Bolotin, V.V.Yanovsky, ''Modified Planck Units'', arXiv 1701.01022v1

[6]G.Gorelik '' First steps of quantum gravity and the Planck values''. In J.Eisenstaedt and A.J. Kox (Eds), Studies in the history of general relativity, Einstein Studies , Vol.3 (pp.364379).Boston.Birkhauser.

[7]Yu.Bolotin, V.A.Cherkaskiy , A.V.Tur and V.V.Yanovsky, ''An ideal quantum clock and Principle of maximum force'',arXiv 1604.01945