The trinity wave-corpuscle-string

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Abstract

We give an experimental verification of the String Theory and a modification of the black body theory in $D-$ dimensional Universe related to this observation. We deduce vacuum energy density in $D-$ dimensional Universe. The possibility of extracting energy from vacuum is examined by AI.

1.What is string theory?:

According to Gasperini & Veneziano the String Theory is *"the assumption that the fundamental components of all matter and force fields existing in nature are one-dimensional extended objects, called "strings""*[1].

At the quantum level a specific length is associated to any massive particle (the Compton wavelength):

$$\lambda_C = \frac{h}{mc} \qquad (1)$$

Where :$h = 6.626196\ 10^{-34}\ joule\ second$: Planck constant;

$c = 2.997924562\ 10^{8}\ meter/second$: speed of light in vacuum

m: mass of the corpuscle.

In string theory there is only one parameter the string tension F which play the role of the mass of the corpuscle. This tension is the energy per unit length of the string. We can also associate to the corpuscle the string length as :

$$\lambda_S = \sqrt{\frac{hc}{F}} \qquad (2)$$

At the deepest level of quantum theory there is only a single F_0 for all possible strings and so this tension corresponds to a fundamental inertiaξ_0 which is the basic building block of matter as the Compton wavelength will be a superposition of many fundamental strings λ_0 as:

$$\lambda_0 = \frac{h}{\xi_0 c} \qquad (3)$$

And in this level we will have:

$$\frac{h}{\xi_0 c} = \sqrt{\frac{hc}{F_0}} \qquad (4)$$

$\xi_0 \& F_0$: are universal constants.

The following steps will be to determine the constants $\xi_0 \& F_0$ in a classic space time (Minkowski space time) and probably to connect this theory with the theory of gravitation.

Quantum strings acquire through quantum mechanics a characteristic size that permit to the string to respect the principle of uncertainty because a very large size costs a lot of energy and a small size implies a very large momentum which allow us to resolve problems in classical mechanics(including General Relativity) dealing with short distances without any singularities(quantization will enter at work).

A string is a superposition of many universal strings $\lambda_0 = \frac{c}{\nu_0}$ in a certain volume to give them density.So in vacuum those universal strings can be the base to estimate the value of vacuum energy density by statistical manner.

2-Vacuum Energy:

In a quasi-flat space time we can consider the energy $E_0 = h\nu_0 = \xi_0 c^2$as an optimum energy for all electromagnetic oscillators in their fundamental states: it is like a temperature of a radiation in a cavity considered as a black body.Than Planck model for black body radiation can be also useful as a model for vacuum energy density with a mean energy of the oscillator at low frequencies to be equal to about$\frac{1}{2} h\nu_0$ where ν_0 is an universal constant. The mean energy of the oscillator will be defined by analogy to Planck model of black body radiation as:

$$U = \frac{\sum_{n=0}^{n=\infty} \frac{n}{2} h\nu . exp(\frac{-\frac{n}{2}h\nu}{\frac{1}{2}h\nu_0})}{\sum_{n=0}^{n=\infty} exp(\frac{-\frac{n}{2}h\nu}{\frac{1}{2}h\nu_0})} = \frac{\frac{1}{2}h\nu}{exp\left(\frac{\nu}{\nu_0}\right)-1} \approx \frac{1}{2} h\nu_0 \; if \; \nu \ll \nu_0 \qquad (5)$$

The total energy density of the vacuum is then according to the model of the black body theory:

$$U_0 = \int_0^\infty \frac{8\pi\nu^2}{c^3} . U d\nu = \int_0^\infty \frac{4\pi h}{c^3} . \frac{\nu^3}{exp\left(\frac{\nu}{\nu_0}\right)-1} d\nu = \frac{4\pi^5 h}{15.c^3} . \nu_0^4 \qquad (6)$$

The energy density of vacuum as given by General Relativity is as follows[2] :

$U_0 = \frac{\Lambda . c^4}{8\pi G} \approx 10^{-9} Joule. m^{-3}$ (7)

With :

$\Lambda = 1.088\ 10^{-52} m^{-2}$: Cosmological constant;

$c = 2.997924562\ \ 10^8 m. s^{-1}$: Light celerity in vacuum;

$G = 6.67\ \ 10^{-11}\ SI\ units$: Gravitationnel constant ;

Equating (6) & (7) we get:

$$\nu_0 = \left[\frac{15\Lambda.c^7}{32.\pi^6 G.\hbar}\right]^{\frac{1}{4}} \approx 0.7149\ 10^{12} Hz \quad (8)$$

It is an infra red frequency which means that Universe is quasi-flat.

Universe is also considered as black body at a temperature $T = 2.72548\ K$. If we consider the fundamental blocks of matter as a perfect gas filling the Universe than this "atom or molecule" of this gas will have an energy equal to $\frac{1}{2} k_B T$ along one space direction.

Considering the Universe as having $D - space\ directions$ than:

$$h\nu_0 = \frac{D-1}{2} k_B T \quad (9)$$

For $D = 3$ we get the particular Planck mean energy of an oscillator in the three space dimensional black body at an equilibrium temperature T.

We should not worry about that vacuum has a temperature because in equation (5) there is full quanta emission of $h\nu_0$. Remember that gases have spontaneous emission of radiation due to absorption of quanta from vacuum.

With $k_B = 1.38\ 10^{-23}\ Joule\ Kelvin$: Boltzmann constant ;

It comes that:

$$D - 1 = \frac{2h\nu_0}{k_B T} = \frac{2x6.626196\ \ 10^{-34} x 0.7149\ 10^{12}}{1.38\ 10^{-23} x 2.72548} = 25.19\ \approx 25 \quad (10)$$

It is the same number of space dimensions predicted by String Theory in a quasi-flat space-time (Minkowski space-time) [3], for a Universefilled with a perfect gas of bosons particles having the energy $h\nu_0$.

By taking $D = 26$ in equation (9) and going back we can determine all the other universal constants. This is an experimental verification of the coherence of the String Theory. For the Universe we can say that there is no big bang, not a pre-big bang but only a separation and agglomeration of the basic blocks of matter which gives us elementary particles, atoms, molecules, black holes , planets & galaxies.

3-Black body radiation in D −Dimensional Universes:

The mean energy of a Planck oscillator at low frequencies should be as given by equation (9) in $D -$ dimensional Universe and in general the mean energy of Planck oscillator is as follows:

$$E_{med} = \frac{h\nu}{\exp\left(\frac{h\nu}{k'_B T}\right) - 1} \quad (11)$$

With :$k'_B = \frac{D-1}{2} k_B$: Boltzmann constant in $D -$ dimensional Universe.

In the form it is the same Planck mean energy by replacing Boltzmann constant k_B with k'_B in the ordinary Planck formulae. 0f course we can obtain this formulae by statistical manner.

The total energy density in a cavity at equilibrium in a temperature T will be as follows [4]:

$$\rho_T = a_D T^{D+1} \qquad (12)$$

With :

$$a_D = \left(\frac{2}{hc}\right)^D \left(\sqrt{\pi}\right)^{D-1} \left(\frac{D-1}{2}\right)^{D+1} {k_B}^{D+1} D(D-1)\Gamma\left(\frac{D+1}{2}\right)\zeta(D+1) \qquad (13)$$

$\Gamma(x) = \int_0^\infty t^{x-1}\, e^{-t} dt$: Gamma function.

$\zeta(x) = \frac{1}{\Gamma(x)} \int_0^\infty \frac{t^{x-1}}{e^t - 1} dt$: Riemann Zeta function (or $\zeta(x) = \sum_{n=1}^\infty n^{-x}$, $Re(x) > 1$)

$D > 1$: number of space dimensions of the Universe.

The generalized Stefan-Boltzmann law or the total energy emitted per unit time and per unit area of the cavity surface known as the *radiancy* is as follows:

$$R_T = \sigma_D T^{D+1} \qquad (14)$$

With :

$$\sigma_D = \left(\frac{2}{c}\right)^{D-1} \left(\sqrt{\pi}\right)^{D-2} \left(\frac{D-1}{2}\right)^{D+1} \frac{k_B^{D+1}}{h^D} D(D-1)\Gamma(\tfrac{D}{2})\zeta(D+1) \qquad (15)$$

4-Vacuum energy in D −dimensional Universe:

The mean energy of an oscillator in vacuum&D −dimensional Universe will be as follows:

$$U_{med0} = \frac{\sum_{n=0}^\infty \frac{n}{2} h\nu \exp\left(\frac{-\frac{n}{2}h\nu}{\frac{D-1}{4}h\nu_0}\right)}{\sum_{n=0}^\infty \exp\left(\frac{-\frac{n}{2}h\nu}{\frac{D-1}{4}h\nu_0}\right)} \qquad (16)$$

For D=3 we will find equation (5).

Than:

$$U_{med0} = \frac{\frac{1}{2}h\nu}{\exp\left(\frac{\frac{1}{2}h\nu}{\frac{D-1}{4}h\nu_0}\right)-1} \qquad (17)$$

So to get vacuum energy density in D −dimensional Universe replace in Cardoso-De Castro formulae of black body $h\ by\ \frac{h}{2}$&$k_B\ by\ \frac{D-1}{4}h$&$T\ by\ \nu_0$ than we get:

$$\rho_{0D} = a_{0D} \nu_0^{D+1} \qquad (18)$$

With:

$$a_{0D} = \frac{1}{4}\left(\frac{1}{c}\right)^{D}\left(\sqrt{\pi}\right)^{D-1} hD(D-1)^{D+2}\Gamma\left(\frac{D+1}{2}\right)\zeta(D+1) \qquad (19)$$

Checking for D=3 we find equation (6).

$1 < D < 26$: there is only 25 space dimensions +1 time dimension in String Theory.

Remarks:

a)-If only there is only one Universe with 26 space-time dimensions than vacuum energy density depends at what number of dimensions we consider it. It will have many accelerations of galaxies.

b)- If there is full quanta of energy emerging from vacuum than it is possible to extract energy from vacuum. Ask AI to give us the circuit to extract energy from vacuum supposed filled with radiation of about $1\,THz$ at very low density and we get the schema of such circuit. It can be realized only by sophisticated companies dealing with nano technologies. The circuit will deliver energy even thought it is dropped in an environment at zero absolute temperature. The energy radiated by vacuum will be as :$W_0 = \frac{c}{4}U_0 = \frac{\pi^5 h}{15.c^2}\nu_0^4$. We need thousands of microscopic antenna per some squared meter surface to receive and redirect this energy.

5-String Theory in Relativity:

It is clear that for the fundamental string that we have :

$$\xi_0 c = \frac{h}{\lambda_0} = a\lambda_0 \qquad (20)$$

With :

$$a = \frac{h\nu_0^2}{c^2} \qquad (21)$$

This is for a particular massless particle having the energy $E_0 = h\nu_0 = \hbar\omega_0 = \xi_0 c^2$. It can be written in a general form as an invariant four vector :

$$\frac{E}{c} = \hbar k^0 \qquad (22)$$

$$\vec{p} = \hbar\vec{k} \qquad (23)$$

The group speed v_g of a packet of waves is the speed at witch we can transmit the energy of the packet. If the corpuscle is considered as packet of waves it is obvious to equate its speed to the group speed ($v_g = v$).

In a way equating the group speed of the packet of waves to the speed of the corpuscle we have:

$$\frac{1}{v} = \frac{1}{v_g} = \frac{dk}{d\omega} = \frac{dk}{dv}\frac{dv}{d\omega} \qquad (24)$$

From (23) and (24) we deduce that:

$$\omega = \frac{\frac{mc^2}{\hbar}}{\sqrt{1-\frac{\vec{v}^2}{c^2}}} + Constant \qquad (25)$$

By Lorentz transformation of the phase $\varphi = \vec{k}.\vec{x} - \omega t$ supposed that it is invariant and the invariant $\left(\frac{E}{c}\right)^2 - \vec{p}^2 = m^2c^2$ we deduce that $Constant = 0$ in equation (25) so:

$$E = \frac{mc^2}{\sqrt{1-\frac{\vec{v}^2}{c^2}}} = \hbar\omega \qquad (26)$$

The second way for wave-corpuscle duality is the De Broglie way which is from equations (24) and (26) he deduce that :

$$\hbar k = p \qquad (27)$$

And so as vectors we get:

$$\hbar\vec{k} = \vec{p} \qquad (28)$$

The vector relation of the wave-vector and the moment which can be deduced from the invariance of the phase with Lorentz transformations [5].

For a corpuscle considered as a string it is obvious to think that we should have :

$$\frac{E}{c} = \xi c = al^0 \qquad (29)$$

$$\vec{p} = a\vec{l} \qquad (30)$$

With:

l^0 and $\vec{l}$ are respectively the components of time and space components of the 4-vector$l^i = (l^0, \vec{l})$,

$$\xi = \frac{m}{\sqrt{1-\frac{\vec{v}^2}{c^2}}} \quad , \quad \vec{p} = \frac{m\vec{v}}{\sqrt{1-\frac{\vec{v}^2}{c^2}}}$$

$l^0 = c\zeta$: string length associated to the particle;

ζ : inertial time of the particle (or dynamical time of the particle). It vary only when the energy of particle vary i.e.:

$d\zeta = dt$: when the energy of the particle vary. Otherwise it is constant.

$\vec{l} = l^1\vec{e}_1 + l^2\vec{e}_2 + l^3\vec{e}_3$:string-vector associated to the particle.

$\vec{e}_1, \vec{e}_2, \vec{e}_3$: unitary vectors and orthogonal one to each other.

It is evident that the 4-vector string$l^i = (l^0, \vec{l})$ is manifestly Lorentz invariant.

The energy of the particle is:

$$E = \xi c^2 = \hbar\omega \qquad (31)$$

It is evident that always we have from (29) the energy per unit length:

$$F = \frac{E}{l^0} = ac = F_0 \qquad (32)$$

By analogy to a corpuscle if we consider that the action of a string as the area swapped along its worldline of motion than when it is at rest the $mass$ of the corpuscle is only an $area$ in space-time.

Space-time becomes dynamical in string theory. The corpuscle is also a packet of strings.

Here we consider the particular case when the corpuscle is in rest. It is clear that the dynamical space part of the corpuscle is the boost :

$$\mathcal{L}_0 = \frac{mc}{a} \qquad (33)$$

The dynamical time part of the corpuscle in rest is the boost:

$$\zeta_0 = \frac{\mathcal{L}_0}{c} = \frac{m}{a} \qquad (34)$$

The minimal area of action in quantum mechanics is [6]:

$$h = m_0 c^2 \tau_0 = a\iota_0^2 \qquad (35)$$

With :$m_0 = a\iota_0 \& \iota_0 = c\tau_0$

Which define the equal footing in of the space-time :

$$\iota_0 = \sqrt{\frac{h}{a}} = \frac{c}{\nu_0} = \lambda_0 \qquad (36)$$

The 26 space dimensions of Minkowski space-time are in fact 24 space dimensions and 2 times dimensions, one time is the ordinary parameter of motion time t which does not stop and another dynamical time ζ as :

$$\xi = a\zeta \qquad (37)$$

With $d\zeta = dt$ when the energy of the corpuscle is varying, otherwise ζ is constant.

A particular mass m_0 is deduced from equations 35 & 36 as:

$$m_0 = \frac{\sqrt{ha}}{c} = \xi_0 \qquad (37)$$

In fact this is the energy of the fundamental string.

A mass is in fact a collection of fundamental strings that form an area.

The phase speed v_f of a packet of waves is the variation of the speed of the equi-phase plans of the plane wave defined as:

$$v_f = \frac{\omega}{k} = \frac{c^2}{v} \qquad (38)$$

We have always:

$$v_g v_f = c^2 \qquad (39)$$

Also we have:

$$v_f = \frac{c^2}{v} = c^2 \frac{dk}{d\omega} = c^2 \frac{d(al)}{d(ac^2\zeta)} = \frac{dl}{d\zeta} \qquad (40)$$

So as vectors ($\vec{l}$ have the same direction as $\vec{k}$) :

$$\vec{v}_f = \frac{d\vec{l}}{d\zeta} \qquad (41)$$

The other way is also verified. If we take by definition that the phase speed is as (40) than we get that :

$$a\vec{l} = \vec{p} + \overrightarrow{Constant} \qquad (42)$$

By the invariance of $(\frac{E}{c})^2 - \vec{p}^2 = m^2c^2 = m^2c^2 - \overrightarrow{Constant}^2$ we get that $\overrightarrow{Constant} = \vec{0}$ and so:

$$a\vec{l} = \vec{p} \qquad (43)$$

6-Application of the dynamic time:

In the following we give some examples of the application of the dynamic time.

Example 1: Determine the work of a force $\vec{f}$ applied on a corpuscle between two points A & B of its trajectory?

$$W_{A\to B} = \int_A^B \vec{f}\,.\,d\vec{x} = \int_A^B \frac{d\vec{p}}{dt}\,.\,\vec{v}dt \int_A^B a\vec{v}_f\,.\,\vec{v}d\zeta = \int_A^B ac^2\,d\zeta = ac^2(\zeta_B - \zeta_A) = \frac{mc^2}{\sqrt{1-\frac{v_B^2}{c^2}}} - \frac{mc^2}{\sqrt{1-\frac{v_A^2}{c^2}}} \qquad (44)$$

We can see how is rich the dynamic time by making calculations easier.

Example 2: Is the phase speed $v_f = \frac{c^2}{v}$ remain available for a corpuscle in continuous acceleration along its linear trajectory?

The phase of the packet is $\varphi = kx - \omega t$. The phase speed is the speed of plans equi-phase i.e. we have:

$\dot{\varphi} = 0$ than

$\frac{dk}{dt}x + kv - \dot{\omega}t - \omega = 0$ so

$\frac{adl}{\hbar dt}x + \frac{pv}{\hbar} - \frac{ac^2t}{\hbar} - \omega = 0$ (*)

$kv = \frac{pv}{\hbar} = \frac{E}{\hbar}.\frac{v^2}{c^2} = \omega\frac{v^2}{c^2}$ than with $v_f = \frac{c^2}{v}$ we have:

$\frac{ac^2}{\hbar}\left(\frac{x}{v} - t\right) = \omega(1 - \frac{v^2}{c^2})$ (**)

But we have by definition:

$v_f = \frac{c^2}{v} = \frac{dl}{d\zeta} = \frac{dl}{dt}$ (***)

$E = pv - L = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}} = ac^2\zeta$ and $L = -mc^2\sqrt{1 - \frac{v^2}{c^2}}$ (****)

Plug (***) and (****) in (*)we get:

$\frac{ac^2}{\hbar}\left(\frac{x}{v} - t\right) = \frac{mc^2}{\hbar}\sqrt{1 - \frac{v^2}{c^2}}$

Plug (**) in the above equation we get:

$\hbar\omega = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}$ which is OK than the definition $v_f = \frac{c^2}{v}$ remain available.

Example 3: Why there is attraction between two corpuscles of masses m & m' and separated by a distance r ? (i.e. why there is universal gravitation ?).

Suppose that we have a corpuscle of mass m in motion towards to another corpuscle of mass m' placed at a distance r.

The corpuscle as a packet of plane waves have a group speed $\vec{v}$ and a phase speed $\vec{v}_f = \frac{c^2}{v}\vec{u}$ with $\vec{u}$ unitary vector of the direction of motion.

We suppose that the phase speed is real and there is really phase waves.

Suppose that the corpuscle is in acceleration. At an instant t the phase speed of plans equiphase in the position of the corpuscle m' is $\vec{v}_f = \frac{d\vec{l}}{d\zeta}$. A few moments later in the same position the phase

speed becomes less than first moment and its variation becomes directed to the corpuscle m. So "$a\Delta\vec{v}_f = \vec{f}'$ " is a force directed to the corpuscle m and acting on the corpuscle m': this is gravitation. In this case the difference of the string vectors is in the same direction of motion and so we can write the phase vector of the corpuscle m' as:

$$\Delta\vec{v}_f = \frac{\vec{l}_2 - \vec{l}_1}{\zeta_1 - \zeta_2} = -\frac{\vec{l}_2 - \vec{l}_1}{\zeta_2 - \zeta_1} \qquad (45)$$

It is exactly the opposite direction of the variation of the speed of the incoming plan waves.

The same thing happen if the corpuscle m is in deceleration. In this case the dynamic time was ζ_1 in the first moment and becomes ζ_2 a few moments later with $\zeta_1 > \zeta_2$ and $l_2 < l_1$ the result will be also a force directed to the corpuscle .

If in the two cases (acceleration & deceleration) the variation of the phase speed of phase waves act as a force on the corpuscles away than if the corpuscle m is in rest the same force will remain acting as an universal force known as universal gravitation. However the situation in rest is relative and according to quantum mechanics the corpuscle never can be in rest.

Remark:

If the frequency ν_0 is independent from the dimensionality of the Universe than there is 22 Universes and everyone have its proper vacuum energy (beginning from $D = 3\ to\ D = 24$) and of course there is different accelerations of galaxies due to the variation of vacuum energy ($D = 2\ is\ excluded\ because\ no\ physiscal\ sens,\ D = 25\ is\ the\ dynamical\ time\ [equivalent\ to\ the\ energy]$ & $D = 26\ is\ the\ ordinary\ time\ t$) and different cosmic microwave background.

If every 4 space dimensions (3 space dimensions +01 dynamic time) are equivalent to a Universe than there is 6 independents Universes+01 Universe which enclose the 6.

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