ADIABATIC TRANSFORMATION OF GRAVITATIONAL STABILIZATION WAVES OF THE CRYSTALLINE VACUUM SPACE INTO BARYONS AT THE BIG BANG.

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Total Number of pages: 30

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ABSTRACT

It is shown that the entropy of the low density monochromatic gravitational waves which stabilize gravitationally the crystalline structure of vacuum cosmic space varies with the volume in the same way as the entropy of an ideal gas formed by particles. This implies that close enough to the local Big-Bang event the energy of all the $2.9 * 10^{124}$ gravitational waves which stabilizes the crystalline structure of vacuum space behaves thermodynamically as though it is consisted of a number $n_B = 1.41 * 10^{84}$ of independent energy or matter quanta (neutrons). Also it is shown that the diminishing in the gravitational energy of the waves which stabilize the crystalline vacuum space structure is the source of energy required to produce the electromagnetic radiation which is responsible for the hot matter expansion through a preexisting infinite cosmic space. Matter and antimatter is produced in equal quantities at the Big Bang region and there are no annihilation events between them during their initial stage of expansion through vacuum cosmic space due to the gravitational stress gradient pattern existing around the source region which has zero gravitational stress all the matter travels globally in one direction (For instance pointing to the long range tension gravitational stress cell-region) and all the antimatter corresponding to the contiguous compressed cell-region travels in the opposite direction. The obtained expression for the volumetric electromagnetic energy density resembles the classical one proportional to T^4 , obtained for the black body radiation in equilibrium conditions at temperature T; and at thermal equilibrium with baryons for the decoupling temperature between photons and matter, $T = 3{,}000\ K$, electromagnetic energy of radiation has a value of 10^{12} photons per baryon. Also the evaluation of the Gibbs´s free energy for the adiabatic compression process of transformation of gravitational stabilization waves of the crystalline vacuum space into baryons at the Big Bang gives a value of zero for the Gibbs´s free energy for all the stages of the compression process as expected. This last result suggests the possibility that every baryon could be considered as a new kind of black hole, an elementary one with hidden entropy of $k * 10^{40}$, such black holes could not suffer evaporation because of the Heisenberg´s Uncertainty Principle.

Key words: Big Bang theory; black body radiation; Heisenberg's uncertainty principle; gravitational waves; black holes.

PACS numbers: 03.50.De, 03.65.-w, 04.20.-q, 61.50.-f, 65.50.+m, 98.80.Ft, 97.60.Lf

1 INTRODUCCION

Recently, several implications of a crystalline model for the vacuum cosmic space with lattice parameter of the order of the neutron radius have been analyzed [1, 2]. In the first paper [1] a formal analogy between dislocation creep and Relativistic Cosmology has been explored. One of the new equations obtained for cosmology has two characteristic distances: the present Universe radius, R_{OU}, and the lattice parameter which is roughly the neutron radius size r_N. In the second paper [2] Using a generalization of the Heisenberg´s uncertainty principle it is shown that the local gravitational stability condition for an infinite tridimensional crystalline model of the quantum vacuum cosmic space (which is existing from an infinite time before the occurrence of our local actual big bang event) implies an equation which relates the temperature, $T(r)$, the radial distance, r, and the energy density, $U(r)$, of the gravitational waves under an adiabatic compression process due to their own interaction. Such equation is formally equal to one previously obtained by Gamow and coworker [3, 4], once pair production has ceased, to predict the present microwave background temperature from the matter density. Gamow's equation arises from general relativity theory as applied to the Big Bang event.

In mathematical language, on the one hand, for the gravitational waves which stabilize the crystalline vacuum space structure under an adiabatic compression process due to their own gravitational interaction, we have [2]:

$$\frac{T(r)}{T_{OU}} = \frac{\mathrm{R_{OU}}}{\mathrm{r}} = \left(\frac{\mathrm{U(r)}}{\mathrm{U_{OU}}}\right)^{\frac{1}{3}} \qquad (1)$$

where $T_{OU} \sim 5.3 * 10^{-32}\ K$, is the absolute temperature of the stabilization gravitational waves, at radius $R_{OU} = 4.3 * 10^{28}\mathrm{cm}$ (Bielewicz & Banday 2011) . U_{OU} is the energy density of such waves at the same radius, that is, $U_{OU} = \frac{E_{OU}}{\frac{4\pi}{3} * (R_{OU})^3}$, where $E_{OU} = 2.9 * 10^{124} * \varepsilon_{OU}$, and ε_{OU} is the energy of each of the $2.9 * 10^{124}$ gravitational waves which contribute to the collective stabilization of the crystalline structure of the crystalline vacuum space. Here, $\varepsilon_{OU} = \frac{hc}{2\pi R_{OU}}$ where h and c are respectively the Planck´s constant and the light velocity.

On the other hand, for the relativistic case we have that once pair production has ceased, ρ , the matter density varies simply as [3-5]

$$\frac{T_l}{T_0} = \frac{L_0}{L_l} = \left(\frac{\rho_l}{\rho_0}\right)^{\frac{1}{3}} \tag{2}$$

where T_l and T_0 are absolute temperatures, L_l and L_0 are radial distances, and ρ_l and ρ_0 are the matter densities. According to Penzias [5]: "If we take T_l and ρ_l to be the radiation temperature and matter density at deuterium formation (10^9K and 10^{+5}g/cm^3), we have the relation first used by Gamow to predict the present temperature of the microwave background from the matter density". The Eqs. (1) and (2) are also formally similar with previous conclusions obtained by Homer Lane in (1869), called to Lane's theorem (as cited by Chandrasekhar [6]) for the uniform expansion of an ideal gas sphere, where particles of such gas are interacting gravitationally.

The equivalence between Eqs. (1) and (2) is meaningful because Eq. (1) is referring to gravitational waves for the crystalline vacuum cosmic space model and Eq. (2) refers to matter packages arising from the Big Bang. And by considering that both processes are adiabatic in nature (compression for the first one and expansion for the Big Bang) then it is possible, by energy conservation, to consider such event as a totally inelastic interaction or collision between incoming gravitational waves and an out coming stream of matter packages from the big bang. In other words, it is possible to imagine such process as a full transformation of such gravitational waves, which stabilize the crystalline structure of the vacuum cosmic space, into matter quanta during the first instants of the Big Bang.

This last hypothesis deserves further exploration because according to usual considerations (see Penrose [7]) the baryons number in the present Universe volume V_{OU} is 10^{80}; and accordingly to our analysis the total energy inside V_{OU} due to gravitational waves for the crystalline structure stabilization of the vacuum cosmic space is

$E_{OU} = 2.9 * 10^{124} * \varepsilon_{OU} = 2.9 * 10^{124} * \frac{hc}{2\pi R_{OU}} = 1.41 * 10^{84} * u_N$, where u_N is the self-energy for a neutron [2].

This transformation of gravitational stabilizing waves of the vacuum space with crystalline structure into matter quanta (neutrons) could be studied in two complementary schemes. First is used a thermodynamic one, second a quantum scheme. This last scheme will be worked out in a separate paper.

In this paper the thermodynamic analysis will be made in two possible ways. First we study the entropy properties of the gravitational self-attracting waves, later an analysis on the Gibbs free energy changes in the crystalline vacuum cosmic space, due to the transformation process of gravitational waves (before mentioned) into matter quanta will be made. This will be followed by the analysis of the production of electromagnetic radiation inside the envelope of the gravitational waves which stabilize the crystalline vacuum space structure under their own gravitational interaction and their associated changes in entropy.

2. THEORY

In this section the following issues will be treated: The thermodynamical aspects of the transformation of the gravitational stabilization waves of the crystalline vacuum space into baryons at the big bang, the Gibbs´s free energy during the adiabatic process of transformation of gravitational stabilization waves of the crystalline vacuum space into baryons at the big bang, the production of electromagnetic radiation inside the envelope of the gravitational waves which stabilize the crystalline vacuum space structure under their own gravitational interaction, the changes on entropy from the beginning of the gravitational stabilization process of the crystalline vacuum space to the present time, and finally the absorption of electromagnetic radiation by of the crystalline structure of the vacuum.

2.1 Thermodynamics of the transformation of gravitational stabilization waves of the crystalline vacuum space into baryons at the big bang.

Before the classical work due to Einstein concerning an heuristic point of view toward the emission and light transformation [8], theoretical physicists consider that a profound formal distinction exists between the theoretical concepts regarding gases and other ponderable bodies and the Maxwellian theory of electromagnetic process in the so - called empty space [8, 9].

Einstein, by obtaining the asymptotic form for the monochromatic electromagnetic radiation entropy at low radiation density and large values of ν/T , shows that such entropy varies with the volume in the same manner as the ideal gas entropy of a dilute solution. And he also shows that low density monochromatic radiation (within the validity range of Wien's radiation formula) behaves thermodynamically as though it consisted of a number of independent energy quanta or discrete energy corpuscles $h\nu$.

It is clear that at the present day is not possible to make experiments concerning gravitational waves, however there are many experimental data for electromagnetic waves; and because for weak gravitational fields, which corresponds to the linear region of the Einstein's field equations there is a strong analogy between Maxwell's and Einstein's equations one would expect that electromagnetic and gravitational waves have a similar behavior. Based in such consideration on the one hand, it is possible to see that the gravitational waves which stabilize the crystalline structure of the vacuum cosmic space obey the following behavior

$$s(\nu_g, T) = -\frac{U_V(\nu_g,T)}{\beta\nu_g}\left[ln\left(\frac{U_V(\nu_g,T)}{\alpha{\nu_g}^3}\right) - 1\right] \qquad (3)$$

Where $s(\nu_g,T)$ is the entropy volumetric density due to gravitational waves of frequency ν_g in the limit of high $\frac{\nu_g}{T}$ ratios. Here $U_V(\nu_g,T)$ is the gravitational waves energy density with frequency ν_g and temperature T. Also α and β have the meaning ascribed to them by Einstein [8, 9].

In our case due to the adiabatic compression process occurring between the gravitational waves which stabilize the vacuum cosmic space of volume V_{OU}, energy is conserved and

$$E_{0U} = U_{0U}V_{0U} = E(\nu_g,T) = U_V(\nu_g,T)V(\nu_g,T) \qquad (4)$$

And, also it is possible to define:

$$S_{0U}(\nu_g,T_{0U}) = s(\nu_g,T_{0U})V_{0U} \qquad (5)$$

and

$$S(\nu_g,T) = s(\nu_g,T)V(\nu_g,T) \qquad (6)$$

Therefore by using Eq. (3) together with Eqs. (4) and (5) it is easy to show that

$$\Delta S_{gw} \equiv S(\nu_g,T) - S_{OU}(\nu_g,T_{OU}) = \frac{E(\nu_g)}{\beta\nu_g}\ln\left(\frac{V}{V_{OU}}\right) \qquad (7)$$

$$\Delta S_{gw} \equiv S(\nu_g,T) - S_{OU}(\nu_g,T_{OU}) = \frac{E(\nu_g)}{\beta\nu_g}\lambda n\left(\frac{V}{V_{OU}}\right) \qquad (6)$$

On the other hand, when inside a volume V we have a gas formed by an arbitrary number,

n_B of matter particles, considered in a first approximation without extension, which are so diluted that do not interact between them; then the entropy of such gas of particles can be described by,

$$\Delta S_{gas} = \frac{R}{N_a} ln\left(\frac{V}{V_{OU}}\right)^{n_B} \quad (8)$$

$$\Delta S_{gas} = \frac{R*n_B}{N_a} \ln\left(\frac{V}{V_{OU}}\right) \quad (9)$$

Where $V < V_{OU}$. By comparing Eq. (7) with Eq. (9) it is clear that the entropy of monochromatic gravitational waves of sufficiently low density varies with the volume in the same manner as the ideal gas entropy of a dilute solution.

The compatibility condition between Eqs. (7) and (9) is:

$$E(\nu_g) = n_B h\nu_g$$

where β has been taken as (*h/k*), with *k* as the Boltzmann's constant [8, 9]. The compatibility condition in a physical sense only admits the solution implied by the Big Bang where n_B denotes the so called Universe baryons number $1.41 * 10^{84}$ inside V_{OU}, with a value for the gravitational waves of frequency $\nu_g = \nu_N$, where ν_N is the neutron frequency. Now, by taking into account Eq. (4), $E(\nu_g) = E_{0U}$. Then

$$E_{0U} = n_B h\nu_N = n_B u_N \quad (10)$$

In other words,

$$E_{OU} = 2.9 * 10^{124}\, h\nu_{OU} = 1.41 * 10^{84} u_N \qquad (11)$$

These equations have the following physical meaning. At the Big Bang, the energy of all the gravitational waves which stabilize the crystalline vacuum cosmic space against gravitational fluctuations behaves thermodynamically as though it consisted of a number n_B of independent energy or matter quanta of magnitude $h\nu_N = u_N$.

2.2 The Gibbs´s free energy during the adiabatic process of transformation of gravitational stabilization waves of the crystalline vacuum space into baryons at the big bang.

The equation (11) allows another complementary interpretation

$$u_N = 2.0 * 10^{40} h\nu_{OU} \qquad (12)$$

which means that the energy of $2.0 * 10^{40}$ gravitational waves for the stabilization of the crystalline structure of the vacuum cosmic space transforms into a matter quanta called neutron. This situation and the occurrence of a previous adiabatic compression process of gravitational waves, open up the possibility that elementary matter quanta could be conceptualized as a new kind of black-hole formed by gravitational waves circling around a center in a similar way to the De Broglie model of matter packages. This possibility will be examined elsewhere.

Equation (10) could be written in terms of the absolute temperature associated to such energy [8,9], namely

$$E_{0U} = n_B k T_{NF} \qquad (13)$$

where u_N has been rewritten as kT_{NF}, with T_{NF} as the temperature for the formation of neutron anti-neutron pairs. $T_{NF} = 10^9\ K$ [3,4].

Then from Eq. (13)

$$n_B k = \frac{E_{0U}}{T_{NF}} \tag{14}$$

And, by using that $E_{OU} = 2.9 * 10^{124} kT_{OU}$ [2] then

$$k * 2.9 * 10^{124} = \frac{E_{OU}}{T_{OU}} \tag{15}$$

Equations (14) and (15) have the classical form of entropy function. By denoting S_{OU} for

k $* 2.9 * 10^{124}$ and S_{NF} for $kn_B = k * 1.41*10^{84}$, we have

$S_{OU} = {E_{OU}}/{T_{OU}}$ and , $S_{NF} = {E_{NF}}/{T_{NF}}$ or

$$S_{OU} = 1.88 * 10^{40} S_{NF} \tag{16}$$

This result explains the low value of the starting Universe entropy at the Big Bang as requested by Penrose [6]. (The associated problem of bounds on the entropy of any object or system of maximum radius R and total energy E [10] as implied by our analysis will be studied in a future paper).

From information provided in this paper it is clear that the internal energy, E_{OU} due to quantum fluctuations to stabilize the crystalline structure of vacuum cosmic space inside a volume V_{OU} is $5.0 * 10^{-41}$ times the internal energy of the perfect crystalline structure of vacuum inside V_{OU} , E_{VC} , $(E_{OU} = 5.0 * 10^{-41} E_{VC})$. In other words, in a thermodynamic scheme we are facing a fluctuation in internal energy of the crystalline structure of vacuum space.

In crystalline physics many of the processes occur under constant volume (here $^{V}/_{V_{OU}} \sim 5.0 * 10^{-41}$) and the Gibbs free energy per unit volume, Gg, is frequently simplified to read [11]

$$G_g = E - TS \tag{17}$$

where E is internal energy, T absolute temperature and S entropy. With E and S as measured relatives to the perfect crystal. Because in our analysis we are facing a fluctuation in the internal energy of the crystalline structure of vacuum space in some conditions the change on G_g will be greater than zero and in other situations the change on G_g will be lower than zero, but in the average a value zero for the change on G_g is expected.

Therefore in our case we have that at the starting of the gravitational stabilization process of the crystalline structure of vacuum $G_g(R_{OU})$ could be calculated, by using equation (15),

$$G_g(R_{OU}) = E_{OU} - T_{OU}S_{OU} = 0 \tag{18}$$

And also for the physical situation where gravitational waves for gravitational stabilization of the crystalline structure of vacuum cosmic space transforms into matter quanta (specifically in neutrons). This means that $(G_g)_{NF}$ appears as

$$(G_g)_{NF} = E_{NF} - T_{NF}S_{NF} = 0 \tag{19}$$

where $E_{NF} = E_{OU}$ because of the adiabatic nature of the self-compression occurring between the previously mentioned gravitational waves, T_{NF} is equal to $10^9 K$ as before, and $S_{NF} = k * 1.41 * 10^{84}$.

Therefore $G_g(R_{OU}) = (G_g)_{NF}$ means that the Gibbs' free energy of the crystalline structure of vacuum space due to quantum fluctuations for gravitational stabilization of vacuum space is equal to the Gibb's free energy of the crystalline structure when $1.41 * 10^{84}$ baryons (neutrons) are formed before the Big Bang begins. And, also it is obvious that $(G_g)_{OU} = (G_g)_{NF} = (G_g)_r(r) = 0$, for any value of r during the adiabatic compression of the gravitational waves for gravitational stabilization of the crystalline structure of vacuum cosmic space .

2.3 Energy conservation and the production of electromagnetic radiation inside the envelope of the gravitational waves which stabilize the crystalline vacuum space structure under their gravitational interaction itself.

During the adiabatic compression process caused by their interaction itself, the gravitational stabilization waves travels at light velocity in vacuum and therefore the diminishing in the gravitational energy of the crystalline field is the energy source required to produce an electromagnetic radiation inside the envelope of such gravitational waves. This electromagnetic radiation is produced by the acceleration of dipolar charges on the polarized vacuum space, under the perturbation caused by the nearby travelling gravitational waves; and gives the energy for a hot matter expansion through a preexisting cosmic space.

In a first approximation, we have that the change in gravitational energy of the stabilization gravitational waves $\Delta E_{grav}(r)$ is equal to the total electromagnetic energy $E_{e-m}(r)$, existing inside the envelope of such gravitational waves.

$$\Delta E_{grav}(r) = -\frac{G E_{OU}^2}{2\, C^4}\left(\frac{1}{r} - \frac{1}{R_{OU}}\right) = E_{e-m}(r) \qquad (20)$$

Where E_{OU} has been taken like$(M_{OU} C^2)$. For $r \ll R_{OU}$,

$$\frac{4\pi r^3}{3}\, u_{e-m}(r) = \frac{G E_{OU}{}^2}{2\, C^4}\left(\frac{1}{r}\right) \qquad (21)$$

With $u_{e-m}(r)$, as the volumetric density of electromagnetic energy. By using the equation (18) from reference [2] it is straightforward to obtain the following expression

$$u_{e-m}(r) = \frac{G E_{OU}{}^2}{2\, (T_{OU} R_{OU}\, C)^4}\,(T(r)\,)^4 \qquad (22)$$

This expression resembles the expression obtained for the black body radiation in equilibrium conditions at temperature T [12]. By defining a cosmological Stephan- Boltzmann constant, $\sigma_{S-BCosmol}$, as

$$\sigma_{S-BCosmol} \equiv \frac{G E_{OU}{}^2}{2\, (T_{OU} R_{OU}\, C)^4} \qquad (23)$$

And using the appropriated constants, a value $\sigma_{S-BCosmol} = 1.39 * 10^{124} ergscm^{-2}s^{-1}K^{-4}$ is obtained; which is $2.45 * 10^{128}$ times greater than the Stephan- Boltzmann constant. Obviously the principle of energy conservation imposes such a coupling value ($\sigma_{S-BCosmol}$) between the electromagnetic phenomena and the quantum collective gravitational phenomena as here described.

The change on the local crystalline gravitational field during the adiabatic compression of the gravitational stabilization waves from R_{OU} to the radius which envelopes $1.41 * 10^{84}$ neutrons is the energy source which produces photons with a global energy of $2.4 * 10^{22} E_{OU} = 2.4 * 10^{106} u_N$ .Such electromagnetic radiation gives the energy for a local hot matter expansion through a preexisting infinite vacuum crystalline space. The interaction between the matter and the antimatter produced in a contiguous coupled cell will be discussed in following papers.

2.4 **Entropy changes from the beginning of the gravitational stabilization process of the crystalline vacuum space to the present time.**

Accordingly to our theory at the radius which envelopes $1.41 * 10^{84}$ neutrons formed at the end of the contraction phase the electromagnetic energy is of $2.4 * 10^{22} E_{OU}$; which means 10^{22} photons for each neutron in such local thermal equilibrium conditions ($T = 10^9 K$). At the present time there exist an agreement that now the microwave temperature has a value of $2.725K$ [13], and the ratio of photons per baryon is of about 10^{8} [14].By using such data it is easy to see that in the phase of the present (local) quantum gravitational fluctuation of the infinite crystalline vacuum space in first $13{,}700 * 10^6$ years previous to the big bang, the entropy diminishes 17 orders of magnitude, from $k * 10^{123}$ to $k * 10^{106}$ at the Big Bang. And in the following $13{,}700 * 10^6$ years counted from the Big Bang the entropy has diminish by other 14 orders of magnitude to a value of $\mathrm{k} * 10^{92}$.

2.5 **Absorption of electromagnetic radiation by of the crystalline structure of the vacuum.**

Also in our scheme the decreasing in the number of photons per baryon after the Big Bang had occurred because the photons absorption by the crystalline structure of vacuum space. These processes occur because during the contraction phase of the stabilization of the vacuum space the diminishing on gravitational energy of the gravitational waves physically has been implied a diminishing of the elastic energy of the physical lattice points which are inside the envelope radius of such waves.

For physical systems far away from thermodynamical equilibrium, has been found that many physical phenomena could be described by first-order differential equations whose solution is an exponential decay to its equilibrium value. Such behavior is common in solid state physics, geophysics, optics, engineering, chemistry and electrochemistry [15]. In particular for crystalline materials it is known that: the general equations for the annealing of vacancies in metals it is shown that the decay curve is exponential [16], also there is an exponential decay in nonlinear termoelasticity [17], and in dislocation creep during a total unloading test there are an exponential decay on dislocation population [18]. In all these cases the system evolution occurs in a monotonic way to its equilibrium value. Based on the previous data it is possible to consider that during the decreasing process of electromagnetic radiation, in the Cosmos after the local Big Bang, the photon population $N_{phot}(t)$ decay exponentially with time,

$$N_{phot}(t) = N_{phot}(t_{BIG\ BANG}) * e^{-(t-t_{BIG\ BANG})/\tau_N} \qquad (24)$$

Where, the photon production by stars at this stage has been neglected, (t) is the chosen time to evaluate the photon population, $t_{BIG\ BANG}$ is the time for the Big Bang process as measured from the beginning of the gravitational instability of the crystalline structure of the cosmic vacuum or chosen zero, τ_N is the relaxation time for the population of photons from the electromagnetic radiation developed originally inside the envelope of the gravitational stabilization waves of the crystalline structure of the vacuum. It is easy to show that after the envelope radius for neutrons it is reached the $\tau_N = 413.75$ million years.

The rate of absorption of photons per unit volume of the crystalline structure of the cosmic vacuum is given by

$$\frac{\left(\frac{dN_{phot}(t)}{dt}\right)^{-}}{V(t)} = -\frac{N_{phot}(t_{BIG\ BANG}) * e^{-(t-t_{BIG\ BANG})/\tau_N}}{V(t) * \tau_N} \qquad (25)$$

For the present time, the Cosmic Microwave Background, CMB, diminishes their population by 10^4 photons per cubic kilometer per second, which is not only a small absolute quantity, but also a very low fractional rate $4.22 * 10^{-14}/s$, which makes it technologically undetectable for the moment. However at previous times the physical processes of photon absorption were much faster than the previously mentioned. For instance, at the decoupling radius the total electromagnetic radiation energy was

$7 * 10^{11} E_{OU}$ the diminishing rate of photon population was of about $0.95 * 10^{40}$ photons per cubic kilometer per second; and may be the changes in radial temperature associated to such events could give place to the galaxy processes formation.

By considering that the crystalline vacuum space filled with the previous electromagnetic radiation before mentioned behaves as common solids [21a], the Newton´s cooling law gives a relaxation time for the temperature associated to Photons $\tau_{Tphot} = 621.2 * 10^6$ years. And finally, the energy absorption by the vacuum crystalline structure has been characterized by a relaxation time $\tau_{e-m\,Ener}$ of about $220.8 * 10^6$ years.

3. DISCUSSION AND CONCLUSIONS

3.1) It has been shown that the entropy of low density monochromatic gravitational waves for the stabilization of the crystalline structure of vacuum space, varies with the volume in the same manner as the entropy of an ideal gas formed by particles. In other words, it has been shown that close enough to the Big Bang, and previous to such process the energy of all the incoming $2.9 * 10^{124}$ gravitational waves (of frequency ν_{OU}) which stabilizes the crystalline vacuum space structure behaves thermodynamically as though it consisted of a number $n_B = 1.41 * 10^{84}$ out coming independent energy of matter quanta of magnitude each (neutrons) $\mathrm{u_N} = \mathrm{h\nu_N} = 2 * 10^{40} * \mathrm{h\nu_{OU}}$. And also as far as we know the standard model of the Big Bang is unable to give a value for the quantity of baryons at the beginning of such process.

3.2) By energy conservation it has been shown that electromagnetic radiation required to get a hot Big Bang has been produced inside the envelope of the gravitational waves which stabilize the crystalline vacuum structure under their own gravitational adiabatic interaction. The obtained expression for such volumetric electromagnetic energy density resembles the classical one proportional to T^4 , for the black body radiation in equilibrium conditions at temperature T. The Stephan- Boltzmann constant for the pre big bang cosmological situation is $2.45 * 10^{128}$ times greater than the Stephan- Boltzmann constant; and is defined as $\sigma_{S-BCosmol} \equiv \frac{G{E_{OU}}^2}{2\,(T_{OU}R_{OU}\,C)^4}$. The change on the local crystalline gravitational field during the adiabatic compression of the gravitational stabilization waves from R_{OU} to the radius which envelopes $1.41 * 10^{84}$ neutrons is the energy source which produces a photon population with a total energy of: $2.4 * 10^{22} E_{OU} = 2.4 * 10^{106} u_N$. At the Big Bang this photons gives the non-coherent repulsive thermal energy required for a local hot matter expansion through a preexisting infinite vacuum crystalline space before the matter-radiation decoupling radius is reached.

3.3) In our scheme neutrons and antineutrons are formed at the same rate. And the mystery of why in the observable Universe only matter it is found it is qualitatively explained as follows (until this point will be fully explained in a further paper): Because of the gravitational stress gradient pattern existing around the source region which has zero gravitational stress [2], all the matter travels in one direction (For instance pointing to the long range tension gravitational stress region) and all the antimatter corresponding to the contiguous cell-region travels in the opposite direction (The corresponding direction associated to the long range compression gravitational stress cell-region) so there are no annihilation events between matter and antimatter during this stage. Similar considerations about matter and antimatter productions in equal quantities, and migration of such produced matter and antimatter in opposite directions under a gravitational stress gradient have been used before by other authors (see Hawking [20]) to propose for instance a quantum mechanism of pair formation at the horizon event radius of black- holes, which causes black-hole evaporation in determined physical conditions). In our scheme, such destruction of matter and antimatter begins to occur at the final stage of the traveling of matter and antimatter through crystalline space when respectively collide with antimatter and matter traveling in opposite direction from contiguous long range compression and tension gravitational stresses cells of the infinite crystalline vacuum structure of cosmic space. Massive destruction-annihilation events between matter (associated to the so called “our Universe”) and antimatter (associated to the next cell contiguous Anti-Universe) will occur at the last stage of the local fluctuation of the crystalline structure of vacuum space around zero gravitational stress.

In other words, our analysis obeys the CPT Theorem which guarantees that a particle and its antiparticle (in particular for baryons) have exactly the same mass and lifetime, and exactly opposite charge for all the times. And we do not require the invention of a hypothetical physical processes as the Baryogenesis model [21] to modify the original standard big bang theory to supposedly annihilate almost the totality of the baryons and antibaryons in order to produce a ratio of 10^8 photons per remaining baryon at the beginning of the big bang in order to describe that the Universe do exist.

3.4) Accordingly to our theory, the entropy for the starting state of gravitational instability at the beginning of the adiabatic compression process of the gravitational waves (final local Universe state) is of $k * 2.9 * 10^{124}$. And our analysis based on energy conservation gives a total entropy of $k * 10^{106}$ at radius which envelopes the $1.41 * 10^{84}$ neutrons formed at the end of the contraction phase of the adiabatic compression process of the gravitational waves; which gives a starting entropy that not only allow us to explain the low value of the starting of the Universe entropy but also the high final value of entropy at the final crunch $k * 10^{123}$(as requested by Penrose [7] or Egan et al [7a]). Therefore it is easy to see that in the phase of the adiabatic compression process of the gravitational waves under their itself interaction $13{,}700 * 10^6$ years previous to the big bang the entropy diminishes 17 orders of magnitude, from $k * 10^{124}$ to $k * 10^{106}$; and in the following $13{,}700 * 10^6$ years counted from the Big Bang the entropy has diminish by other 14 orders of magnitude to a value of $k * 10^{92}$.

3.5) In our theoretical scheme the crystalline structure of the vacuum produces an absorption of electromagnetic radiation. This phenomenon occurs because the physical source for the electromagnetic radiation energy production during the adiabatic compression of gravitational waves has implied a diminishing of the elastic energy of the physical lattice points which are inside the envelope radius of such waves.

After the Big Bang, the relaxation time τ_N for the population of photons from the electromagnetic radiation developed originally inside the envelope of the gravitational stabilization waves of the crystalline structure of the vacuum is $\tau_N = 413.75$ million years. The Newton´s cooling law gives a relaxation time for the temperature associated to Photons $\tau_{Tphot} = 621.2 * 10^6$ years. And finally, the energy absorption by the vacuum crystalline structure has characterized by a relaxation time $\tau_{e-m\,Ener}$ of about $220.8 * 10^6$ years. No one of the previous phenomena has been considered by the standard theory of the Big Bang.

The rate of absorption of photons per unit volume of the crystalline structure of the cosmic vacuum at the decoupling radius between matter and radiation gives a diminishing rate of photon population of about $0.95 * 10^{40}$ photons per cubic kilometer per second. At an epoch 380,000 years after the Big Bang, the little changes in radial temperature of the black body electromagnetic radiation caused by the absorption phenomena could give place to local variations in the density of “our” infant Universe. Such density variations in principle determinate the galaxy processes formation and their spatial distribution [24a]. At difference of some of the mathematical fancy models used to explain the joint evolution of quasars, galaxies and their large-scale distribution without consider a solid physics by the standard theory [23], the proposed mechanism explains how the cosmic vacuum space behaves after the decoupling radius it is reached. And consequently answer the question raised by Joseph et al [24, 25] "What happened to the heat? (in the standard theory after the decoupling radius it is reached) if everything was contained in a super-hot expanding universe which originated as a singularity, then there could be no "cold sink" or thus no cooling due to conduction or convection and temperature disequilibrium”. In other words, our theoretical scheme obeys the principle of energy conservation, because the space is an infinite (in extension and eternal in duration) crystalline vacuum cosmic structure which experiment gravitational-energy fluctuations of about of $5 * 10^{-41}$ in volumes of the size of the actual Universe which is compatible with generalized Heisenberg´s Uncertainty Principle [2]. Such constancy about energy or about the physical space quantity is not obeyed by the standard theory, and by any of their associated models. But also according to Baryshev [26] the supposed space expansion in the standard theory occurs in a very extraneous way: Such theoretical space expansion supposedly occurs in the space between galaxies but not inside bounded physical objects like particles, atoms, stars and galaxies. So inside these objects there is no space creation. This is why the creation of space is a new cosmological phenomenon, which cannot be tested in laboratory because the Earth, the Solar System and the Galaxy do not expand.

3.6) Also there is a possible connection between equations (14) and (15) with expressions for the entropy of black holes. Both equations resemble an expression for the entropy of a black hole, S_{BH}, due to Bekenstein [27] and Hawking [28] which if it is taken seriously [29] allows to exhibit that the first law of the thermodynamics dictates that black holes must have a temperature T, as follows

$$d(M_{BH}c^2) = TdS_{BH} \qquad (26)$$

where M_{BH} is the total mass of the black hole. This equation could be expressed as

$$dS_{BH} = \frac{d(M_{BH}c^2)}{T} \qquad (27)$$

It is clear that Eqs. (14) and (15) used together with Eq. (11) have the same form and physical meaning of Eq. (18) and therefore the possibility exists that elementary particles could be conceptualized as a new kind of black hole, which could not evaporate by the action of the quantum Heisenberg´s Uncertainty Principle. Additionally equation (12) for the self-energy of a neutron considered as $2.0 * 10^{40}$ times the fundamental quantum of gravitational wave for the stabilization of the crystalline vacuum space $h\nu_{OU}$ support also such possibility because the entropy of $k * 2.9 * 10^{124}$ gravitational waves becomes into an entropy of $k * 1.41 * 10^{84}$ at the big bang beginning; giving place to a hidden entropy inside this new kind of elementary black holes. This possibility will be studied in a following paper.

3.7) In nature crystals are never perfect, and it is well understood that they may contain many defects. One of the most important is called a vacancy. When vacancies are introduced into the crystalline structure the internal energy of the crystal increases and the entropy of the crystal increases too, but the Gibbs free energy diminishes until equilibrium value is reached.

In our case, the situation is different because of the role that gravitation forces play in relation to the crystalline structure of vacuum cosmic space. Equations (18) and (19) and the results obtained in reference [2], allow us to consider, according to Boltzmann's analysis [30], that the degraded energy of the crystalline vacuum cosmic space of volume V_{OU} which is in the most probable form of gravitational waves with frequency ν_{OU}, lead to mutual gravitational interactions giving place to a "visible" and coordinate motion which behaves like heat of very high temperature that can be completely transformed into work. Not only $\mathrm{E_{OU}} = \mathrm{E_{NF}}$ but all the energy E_{OU} of gravitational compressed waves transforms into matter quanta with total energy $E_{NF} = 1.41 * 10^{84} u_N$. This situation is similar to the one which has been observed in plastic deformation [31] where coherent elastic waves generated during an unloading process, travel along a deformed crystal to concentrate at dislocation sources giving place to a full transformation of the energy of the elastic waves into crystal defects called dislocations. In other word, during the plastic deformation process which occurs during an unloading test, energy in the form of coherent elastic sound waves, which have a very high entropy, give place to the production of dislocations (which have a very low configuration entropy) but have the same stored elastic energy that the original elastic waves. The resemblance between the plastic deformation case above described with the elastic gravitational waves involved in the Cosmic case it is outstanding.

3.8) Additionally, if we take into account that gravitational long range cosmological stresses and quantum effective forces acting on the crystalline structure of vacuum do not appear in an explicit way in Eqs. (18) and (19) it is possible to arrive at an apparent paradoxical situation where Eqs. (18) and (19) do not describe to an absolute minimum in the Gibbs' free energy but to a relative minimum, due to the following reasons. Defining a generalized Gibbs' free energy, $G_{g-e-m}(r)$, which includes the electromagnetic radiation it is clear that coincides with the value of $G_g(r)$ for R_{OU} ; and during the compression stage of the gravitational waves for $r < R_{OU}$ have lower values until reaches a minimum transitory value of about ($-kT_{NF} * 10^{106}$), where k is the Boltzmann´s constant and $T_{NF} = 10^9\ K$. After the Big Bang, $G_{g-e-m}(r)$ grows because the photon absorption processes occurring at the crystalline structure of the vacuum cosmic space; and also when matter and antimatter (which were produced in the neighboring Universe cell and travel in opposite sense to matter facing the same cosmic gravitational stress gradient) “collides” and annihilate between them liberating the waves gravitational stored energy into the baryons and antibaryons. Such processes lead to the rise of free energy to the previous value before the gravitational instability begins in an infinite cycle of quantum gravitational fluctuations around zero gravitational stress on the crystalline structure of the infinite vacuum cosmos.

3.9) Relative to the general characteristics of the whole gravitational stabilization process of the crystalline structure of the cosmic vacuum in few words it is possible to state that before the stabilization process begins at R_{OU} the system has: Maximum Gravitational Energy, Minimum Electromagnetic Energy, Maximum Thermal Equilibrium on the Vacuum Cosmic Space of Volume V_{OU} , Maximum Entropy, Relative Maximum Value of Gibbs´ Free Energy. And at the Neutron Radius has: Minimum Gravitational Energy, Maximum Electromagnetic Energy, Minimum Thermal Equilibrium on the Vacuum Cosmic Space of Volume V_{OU} , Minimum Entropy, Relative Minimum Value of Gibbs´ Free Energy.

4.0) Finally we remark that the standard theory do not give the starting quantity of baryons of the Universe, neither the photon ratio per baryon. And also the standard theory violates the energy conservation principle by creating huge quantities of quantum vacuum space from literately nothing. Neither of the previous problems appears in our theory which considers that the eternal and infinite vacuum cosmic space have crystalline structure and the gravitational instabilities here analyzed do not alter its Euclidean nature in more than $5 * 10^{-41}$.

Accordingly to Baryshev´s analysis [32], the main conceptual problems of the Standard Cosmological Model are consequence that in fact, all fundamental forces in physics (strong, weak, electromagnetic) have quantum nature, (i.e. there are quanta of corresponding fields which carry the energy-momentum of the physical interactions), while General Relativity is a non-quantum theory, which presents the geometrical interpretation of gravitational force (i.e.

The curvature of space itself which is not material field in space) and exclude the concept of localizable gravitational energy.

From long time ago some theories called Flat space-time field Theory of Gravitation has been developed for weak gravitational fields by classical works of Birkhoff [33],Barajas [34], Graef et al[35], Weyl [36], and Moshinsky [37]. Such theories build up in a Minkowskian space-time frame lead to conservation laws for instance: for energy, momentum and angular momentum, including gravitational field as required to develop a quantum field theory of gravitation.

As far as we know there exist at least 16 types of proto - quantum gravity theories [38], among them the theories due to Moshinsky [37] and Feynman [39] are based on a weak gravitational field approaches or flat space –time gravitation field theories. The Moshinsky´s approach for the non-quantum case, gives the same expressions as the Einstein´s theory due for their classical gravitational problems. And for quantum problems Moshinsky obtains the following results: The Dirac wave equation for an electron moving in a combined gravitational and electromagnetic field, the effect of an external gravitational field on the hydrogen atom, and finally a gravitational correction to the magnetic moment of the electron. And close their analysis with the following assertion: "The observed gravitational effects can be explained quite simply in terms of the interaction of Birkhoff¨s gravitational field with other fields. The mathematical simplicity of flat space-time gravitational theories, suggest that they could be used with profit in the study of the classical and quantum aspects of field theories". The last statement due to Moshinsky, is in agreement with the following quote due to Baryshev [40], "Birkhoff was the first who formulated "the principle of universality of the gravitational interaction" according to which all kinds of matter interact with gravitational field through its energy-momentum tensor (EMT) of gravitational field in its traditional form allows for the ordinary quantization of gravitational field in the Field Theory of Gravitation (FTG). In other words, in a flat Minkowsky space- time it is possible to consider gravitation in the same way as other physical interactions, i.e. as a quantum field in flat space-time background".

Recent experiments about the quantum nature of the interaction between neutrons and weak gravitational field of planet Earth [41, 42] give support to the previous ideas. In this vein, theoretical analysis here reported opens the possibility that a quantum gravitational flat space-time field theory will be fully developed to describe the fundamental cosmic phenomenon which has been treated here by using toy models.

ACKNOWLEDGEMENTS

We acknowledge to the Technician G. Moreno for her stupendous work.

REFERENCES

[1] Montemayor-Aldrete J A, Muñoz-Andrade J D, Mendoza-Allende A and Montemayor-Varela A. (2005). Analogy between dislocation creep and relativistic cosmology. Rev. Mex. Fís. **51**, 461-475.

[2] Montemayor-Aldrete J A, Morones-Ibarra J R, Morales-Mori A, Mendoza-Allende A. and Montemayor-Varela A. (2011). Gravitational Stability for a Vacuum Cosmic Space Crystalline Model. Journal of Cosmology, **18**,7978-7998.

[3] Gamow G. (1948). The evolution of the universe. *Nature* **162,** 680-682.

[4] Alper R. A. and Herman R. (1948). Evolution of the Universe. *Nature* **162,** 774-775.

[5] Penzias A. A. (1977). in *Cosmology, History and Theology*. Edited by Yourgraw W. and Breck A. D. Plenum Press, New York p.101.

[6] Chandrasekhar S. (1939). *An Introduction to the Study of Stellar Structure.* The University of Chicago Press, Chicago, Illinois p.47.

[7] Penrose R. (1989). *The Emperor's New Mind*, Oxford University Press. New York pp.340.

[7a]. Egan C.A. and Linewaver C.H. (2010). A LARGER ESTIMATE OF THE ENTROPY OF THE UNIVERSE. The Astrophysical J. 710:1825–1834. doi:10.1088/0004-637X/710/2/1825

[8] Einstein A. (1905). ber einen die Erzeugung und Verwandlung des Lichtes Betreffenden Heuristischen Gesichtspunkt . *Ann Physic* **17,** 132-148.

[9] Arons A. B. and Peppard M. B. (1965). Einstein´s Proposal of the Photon Concept – a Translation of the Annalen der Physik paper of 1905. *Amer. J. Phys.* **33,** 367-374.

[10] Bekenstein J. D. (1981). Universal upper bound on the entropy-to-energy ratio for bounded systems. *Phys. Rev. D* **23,** 287-298.

[11] Reed-Hill R. E. (1964) *Physical Metallurgy Principle*, D. Van Nostrand Co. Inc. Princeton, New Jersey pp.159.

[12] Sommerfeld A. (1956).Thermodynamics and Statistical Mechanics, Academic Press, New York.

[13] Noterdaeme P. , Petitjean P. , Srianand R. , Ledoux C. , and López S.(2011). The evolution of the cosmic microwave background temperature. Astronomy & Astrophysics. **526**, L7. DOI: 10.1051/0004-6361/201016140

[14] Penrose, R. [1981]: "Time-Asymmetry and Quantum Gravity", in C.J. Isham and R. Penrose and D.W. Sciama (eds) Quantum Gravity 2: A Second Oxford Symposium, Oxford: Clarendon Press, pp. 245-72.

[15] Istratov A. A. and Vyvenko O. F. (1999). “Exponential analysis in physical phenomena,” Review of Scientific Instruments. **70**, 1233–1257.

[16] Damask A. C. and Dienes G. J. (1960). “Theory of vacancy annealing in impure metals,” Physical Review. **120**, 99–104.

[17] Muñoz Rivera J. E. and Kamei Barreto R.(1998). “Existence and exponential decay in nonlinear thermoelasticity,” Nonlinear Analysis: Theory, Methods and Applications. **31**,149–162.

[18] Montemayor-Aldrete J. A. and Lopez de Haro M.(1994). “A statistical mechanical approach to dislocation creep and the total unloading test on Al-11wt Zn alloy,” in Advances in Science, Technology and Applications of Zn-Al Alloys. G. Torres Villaseñor, Y. H. Zhu, and C. Piña, Eds., pp. 115–1120, U.N.A.M., México, México.

[19] Bieberle-Hütter A. (2008). A micro-solid oxide fuel cell system as battery replacement. Journal of Power Sources **177**, 123–130.

[20] Hawking S. W. (1975). Particle creation by black holes. Commun. Math. Phys. 43, 199-220.

[21] Sakharov A.D. (1967). Violation of CP invariance, C asymmetry, and baryon asymmetry of the universe. Journal of Experimental and Theoretical Physics **5**, 24–27.

[22] Peebles P. J. E. (1965). The Black-Body radiation content of the Universe and Formation of galaxies. The Astrophysical Journal, **142**, 1317- 1326.

[23] Springel V. et al. (2005).Simulating the joint evolution of quasars, galaxies and their large-scale distribution. arXiv:astro-ph/0504097v2.

[24] Joseph, R. (2009). The Myth of the Big Bang. Cosmology. com/BigBangMyth. html, 2009

[25] Kumar A., and Joseph R. (2010). Big Bang? A Critical Review. Journal of Cosmology. **6**, 1533-1547.

[26] Baryshev Y. (2008).Expanding Space: The Root of Conceptual Problems of the Cosmological Physics. http://arxiv.org/ftp/arxiv/papers/0810/0810.0153.pdf

[27] Bekenstein J. D. (1972). Black Holes and the Second Law. *Lettere al Nuovo Cimento* **4,** 737-740.

[28] Bardeen J. M., Carter B. and Hawking S. W. (1973). The four laws of black hole mechanics. *Commun. Math. Phys.* **31** 161-170.

[29] Bousso R. (2002). The holographic principle. *Rev. Modern Phys.* **74,** 825-874.

[30] Boltzmann L., (1974). Theoretical Physics and Philosophical Problems. (Edited by B. McGuinness) D. Reidel Publishing Co. Dordrecht-Holland p.22.

[31] Montemayor-Aldrete J. A., Mendoza-Allende A. and Orozco E. (1993). About the internal stress measurements during sigmoidal transient creep on Cu 16at%Al". Mater. Sci. Eng. **A160** ,71-79.

[32] Baryshev Y.V. (2005). Conceptual Problems of the Standard Cosmological Model http://arXiv:astro-ph/0509800v1

[33] Birkhoff G.D. (1944). Flat space- time and gravitation. PROC. N. A. S. 324-334.

[34] Barajas A. (1944). Birkhoff´s theory of gravitation and Einstein´s theory for weak fields. PROC. N. A. S. 54-57.

[35] Barajas A., Birkhoff G. D., Graef C. and Sandoval -Vallarta M. (1944).

On Birkhoff's New Theory of Gravitation. Phys. Rev. **66**, 138–143.

[36] Weyl H. (1944). How far can one get with a linear field theory of gravitation in flat space-time? Amer. J. Math., **66**, 591-603.

[37] Moshinsky M. (1950). On the Interactions of Birkhoff's Gravitational Field with the Electromagnetic and Pair Fields. Phys. Rev. **80**, 514–519.

[38] Esposito G. (2011). “An introduction to quantum gravity” arXiv:1108.3269v1 [hep-th]
[39]] Feynman R. (1963). “Quantum Theory of Gravitation" Acta Physica Polonica XXIV, 697-722.
[40] Baryshev Y.V. (1999). Field Theory of Gravitation: Desire and Reality.
arXiv:gr-qc/9912003v1
[41] Nesvizhevsky V.V. et al (2002). Quantum states of neutrons in the Earth's gravitational field. Nature 415, 297-299.
[42] Nesvizhevsky V.V. et al (2005). Study of the neutron quantum states in the gravity field
http://arxiv.org/ftp/hep-ph/papers/0502/0502081.pdf