Chapter 5. Energy of the Physical Vacuum. Hidden space energy.

The analysis of CL node dynamics in Chapter 2 and 4 of BSM leads to the conclusion that CL space contains distributed Zero Point Energy (ZPE), which is of two types: a static energy (ZPE-S) and a dynamic energy (ZPE-D).

ZPE-S is the energy that keeps the CL nodes at proper internode distance. This energy is quite large, since it involves the superstrong SG field between the two types of nodes, formed respectively by the two types of prisms. An important parameter for this field is derived in Chapter 9 and denoted as C_{SG}, while the possible physical origin of the superstrong SG field is further discussed in Chapter 12 indicating that SG field is likely related to the super-high Planck's frequency given by the expression:

$$f_{PL} = \sqrt{\frac{2\pi c^5}{hG}} = 1.855 \times 10^{43} \quad \text{(Hz)} \qquad (2.0)$$

ZPE-D is a the vibrational energy of the permanently oscillating CL nodes. Its intrinsic parameters are the node resonance frequency and the SPM (Spatial Precession Mode) frequency. The first one is related to the velocity of light, while the second one to its constancy in an uniform space medium. (SPM frequency is equal to the Compton frequency, valid for the Earth gravitational field (General Relativistic effect)). The relation of these two parameters to the permeability (μ_0) and permittivity (ε_0) of free space defines the light velocity by the well known equation $c = (\varepsilon_0\mu_0)^{-1/2}$. In fact the constant value of ε_0 and μ_0 are result of the common synchronization of the oscillating CL nodes. This synchronization is assured by permanently existed spatially and time recombined Zero Point waves, which can be regarded as a magnetic protodomains. So ZPE-D is directly related to the zero point waves as discussed in Chapter 2.

ZPE-S is related to the Static pressure, while ZPE-D - to the Dynamic pressure of the CL space as discussed in §3.13 Chapter 3 of BSM. The Static pressure is also related to the Newtonian mass of the elementary particles, while the Dynamic pressure is related to the magnetic and electrical interactions. Presently, the contemporary physics identifies a zero point energy related only to the magnetic and electrical interactions. This corresponds to ZPE-D according to BSM concept.

ZPE-S is out of vision in contemporary physics, due to the currently adopted concept about space. In fact this is the energy behind the nuclear atomic energy, but presently it is not envisioned as a space energy. While the nuclear binding energy is correctly expressed by the Einstein equation $E = mc^2$, the real source of the nuclear atomic energy and its physical presence in space has not been properly understood so far.

If referenced per unite space volume, ZPE-S is much larger than ZPE-D. The huge difference between them could be understood if using an analogy with the energy of the ocean waves. ZPE-D is analogous to the energy of the ocean waves carried by a layer with a small thickness in comparison to its depth and normalized to unit surface area. The ZPE-S is analogous to the potential energy of a column of water under the same unit area. If a zunamy wave is invoked by an Earth quake, for example, the released energy is enormous and it transfers to strong tides and waves when approaching the cost. This energy analogically corresponds to the hidden ZPE-S energy of the physical vacuum. ZPE-S is responsible for the constant internode distance of the CL structure, in which the SG law is directly involved. (this specifics of the SG law is discussed in Chapter 12). BSM theory predicts that it could be accessed by some particular interactions between elementary particles and the ZPE-D energy. Since the physical vacuum structure has ability to keep a constant ZPE-D, the extracted portion of ZPE-D is refilled by ZPE-S, which is unlimited. Some particle physics experiments provided in the particle accelerators show a signature of accessing the ZPE-S. In the collision of accelerated high energy particles some jets often appear with energy much larger than the input energy of the colliding particles. These phenomena known as Regge resonances appear as “infinities” (from energetic point of view) in the Feynman's diagrams. Contemporary modern physics does not have explanation about the origin of this energy.

5.1. Zero point energy of CL space and its relation to the Cosmic Background Radiation

According to BSM theory, the Cosmic Background Radiation, known also as a relict radiation, is not a simple signature of the Universe evolution. It originates from every point of CL space, so it carries information about the distributed space energy and more specifically the ZPE-D. The deep space contains rarefied gas in a state of cold cosmic plasma. In such environment, the gas molecules or atoms are in dynamic equilibrium with the surrounding CL nodes. This equilibrium involves absorption of zero order waves (ZPE waves) from the gas molecules or atoms and emission of photons, while the total energy balance of the system of the gas particles and the surrounding CL space is preserved. The most abundant interstellar gas is an atomic and molecular Hydrogen. This fact facilitates the estimation of the ZPE and permits to determine one important parameter of the proton - the volume of its envelope. This parameter is later used in Chapter 6 of BSM for obtaining the physical dimensions of the proton with its substructures by cross calculations with other experimentally determined parameters.

5.2. Derivation of expressions about CL space background temperature.

The following method is based on two fundamental expressions: The first one is the well-known in the Classical termodynamics equation of the ideal gas and the second one is the Dynamical pressure of CL space, derived in Chapter 3. The ideal gas equation is:

$$R_{ig} = \frac{PV_{\mu}}{T} \tag{5.1}$$

where: R_{ig} = 8.31451 *(J kmol⁻¹)* - is the universal gas constant; V_{μ} is the molar volume at absolute temperature T.

The ideal gas constant is an experimentally measured physical parameter for a gas in conditions when it behaves as an ideal gas.

The CL space dynamical pressure, P_D , is given by Eq (3.61) (Chapter 3 of BSM).

$$P_D = \frac{h\nu_c}{cS_e} = \frac{h\nu_c}{4\pi^2 cR_c r_e} \qquad \left[\frac{N}{m^2 Hz}\right] \tag{5.2}$$

where: h - is a Plank's constant, ν_c - is a Compton frequency, c - is the velocity of light, R_c is the Compton radius, r_e is the small electrons structure radius.

In conditions of dynamical equilibrium, the hydrogen atom gets momentum from the ZPE waves in a form of dynamical pressure on the proton envelope. The surface of the proton envelope, considered as a torus, is given by the envelope of the proton circumference $2\pi(R_c + r_p)$ and its axial length L_{pc}.

$$S_p = 2\pi(R + r_p)L_{pc} \tag{5.3}$$

The dynamical force exercised by the CL space on the proton surface is:

$$F_D = P_D S_p = \frac{h\nu_c(R_c + r_p)L_{pc}}{2\pi cR_c r_e} \tag{5.4}$$

The pressure unit in SI system is [N/m^2]. This means that the resultant total force should be referenced to a unit surface of 1 m^2. In such case, the pressure can be regarded as a sum of bouncing individual forces on large number of protons, while the resultant force is reference to a virtual wall with an area of $S_W = 1\ \mathrm{m}^2$.

The number of protons in one molar volume of atomic hydrogen is given by the Avogadro number N_A. Then the resultant force on a virtual wall from N_A number of protons is $\Sigma F_D = N_A F_D$. Normalizing the resultant force to a virtual wall with an unite area of 1 m^2, we get the normalized value of the exercised pressure:

$$P = \frac{\Sigma F_D}{S_W} = \frac{N_A F_D}{S_W} = \frac{N_A h\nu_c(R_c + r_p)L_{pc}}{2\pi cR_c r_e} \tag{5.5}$$

Let us consider a quantity of one *mol* of neutral Hydrogen atoms in a deep space. This could be regarded as a normal CL space environment, in which the atoms are in a dynamical equilibrium with ZPE-D. This equilibrium could be estimated by the dynamical CL pressure exercised on the proton. It has been mentioned that the dynamical CL pressure is caused by the zero point waves, responsible for equalization of ZPE; this means a background temperature uniformity of CL space. The dynamical equilibrium means that the energy obtained by the hydrogen atom will be equal to the energy radiated back into space. Obviously, the radiated energy should be contributed by energy level transitions in the atomic and molecular hydrogen. It is performed by small amount of atoms distributed in the space, so the optical depth is quite large. This conditions allow us to consider that the hydrogen distributed in deep space behaves as an ideal gas. The distance between atoms is large enough in order to eliminate the collision effect. The background temperature is also very low, so we may consider that the photon energy exchange between the atoms in such environments is negligible. In such conditions the probability of the hydrogen electron to be in a ground state is high. But the electron could never stop its motion in the quantum orbits. So it will have a continuous interaction with the CL space by its magnetic moment. This means that the Hydrogen atom will have some finite velocity different than zero. The physical effect of such motion is some small but finite pressure. In order to estimate this pressure we need to define a finite volume. Such volume could be the molar volume. It could be defined as:

$$V_{\mu} = V_H N_A \qquad (5.6)$$

where: N_A - is the Avogadro number

V_H - is the Hydrogen volume, considered as a neutral in the interactions with the zero point waves (related to ZPE-D).

The interacting volume should be some volume around the proton core where the interaction takes place. It is very probable this to be the volume enclosed by the Bohr surface, so in the outside volume the atom should behave as a neutral (the system of proton and orbiting electron appears externally neutral). Then comparing such described system of Hydrogen (possessing the mentioned hydrogen volume connected to the Avogadro number) with a similar volume defined for a single neutron, we see that they both exhibit the following common features:

- they appear neutral in the far field
- in the near field they exhibit magnetic field
- the proximity electrical field of the neutron is locked by the SG(CP) forces due to the symmetrical spatial configuration
- the proximity field of the proton in the Hydrogen is locked inside the Bohr surface due to the proximity coupling with the electrical field of the orbiting electron in a quantum quasishrunk space (see Chapters 7 and 9 of BSM).

The above features provide possibility to replace the magnetic interaction (with CL space) of the moving neutral Hydrogen by the magnetic interaction of the neutron. So we can use some of the neutron's parameters and more specifically its magnetic moment as a dynamical interaction with the CL space.

Let us examine firstly, could the following relation be correct: $V_H/V_p = m_p/m_e$, where V_H is the above defined volume, V_p - is the volume of the proton envelop, m_p and m_e - the proton's and electron's masses. From well known relation $m_p/m_e = \mu_e/\mu_p$, where μ_e and μ_p are respectively the magnetic moments of the electron and the proton we arrive to $V_H/V_p = \mu_e/\mu_p$. While the left side of this relation is a volume ratio between a neutral (hydrogen) and a charged particle (proton), the right side is a magnetic moment ratio between two charge particles (electron and proton). According to the above mentioned considerations for neutrality of the hydrogen, we may replace the magnetic moment of the proton μ_p with the magnetic moment of the neutron μ_n.

$$\frac{V_H}{V_P} = \frac{\mu_e}{\mu_n} \qquad (5.6.a)$$

The envelope volume of the proton structure (whose surface is expressed by Eq. (5.2)) is:

$$V_p = \pi(R_c + r_p)^2 L_{pc} \qquad (5.6.b)$$

Combining Eqs. (5.6), (5.6.a) and (5.6.b) we may express the interaction molar volume of the hydrogen as:

$$V_{\mu} = \left(\frac{\mu_e}{\mu_n}\right)\pi(R + r_p)^2 L_{pc} N_A \qquad (5.7)$$

Substituting (5.5) and (5.7) in Eq. (5.1) we obtain the equation of the CL space background temperature.

$$T = \frac{N_A^2}{S_W}\frac{h\nu_c(R_c + r_p)^3 L_{pc}^2}{2cR_c r_e R_{ig}}\left(\frac{\mu_e}{\mu_n}\right) \quad [\mathrm{K}] \qquad (5.8)$$

where: $S_W = 1$ (m^2) - is a reference wall area

The proton core length L_{pc}, obtained directly from Eq. (5.8) is:

$$L_{pc} = \frac{1}{N_A}\left(\frac{2cR_c r_e T S_W R_{ig}}{h\nu_c(R_c + r_p)^3}\frac{\mu_n}{\mu_e}\right)^{1/2} \quad [\mathrm{m}] \qquad (5.9)$$

The measured background temperature by COBE experiment is:

$$T_{exp} = 2.726 \pm 0.01 \quad [\mathrm{K}] \qquad (5.10)$$

Then from Eq.(5.7) we obtain

$L_{pc} = 1.6429\times10^{-10}$ (m), but this is still approximate value. In §6.12.2.1 (Chapter 6 of BSM), we use this value and by strobing with other experimental data we obtained the accurate value for the proton core length

$$L_{pc} = 1.6277\times10^{-10} \quad m] \qquad (5.11)$$

This value is extensively used in number of expressions, especially in Chapters 9 and 10 of BSM. It matches quite well the theoretical results and the experimental data.

The calculated background temperature for L_{pc} according to (5.11) is:

$$T = 2.6758 \quad [K] \qquad (5.12)$$

The difference between the estimated temperature by BSM and the experimentally measured one is only 0.05K.

The CMB (cosmic microwave background) temperature is measured by a satellite looking in a deep space, while the universal gas constant is measured in Earth conditions. Some difference may exist between the ZPE-D of the deep space and the Earth local field that could be a result of the Earth gravitation influence on the CL density. This is kind of General relativistic effect.

The concept applied for the Hydrogen in fact should be valid for any other simple molecule, because, the zero point waves have a very short wave-train. Therefore, in conditions of dynamical equilibrium in a deep space, a large number of molecules could be involved. The resultant spectrum obtained as a summation of their radiation may have an envelope approaching the theoretical curve of the blackbody radiation the maximum of which is the estimated temperature of 2.72K

5.3. CL space background temperature expressed by the parameters of CL space.

The deep space background temperature is a pure CL space parameter existing in both conditions: a deep space and in a vicinity of a massive objects as well. The first option indicates that it could be expressed directly by some of the intrinsic parameters of CL space. In order to obtain such expression we must replace the proton and electron geometrical parameters in Eq. (5.6) with pure CL space parameters.

The proton length L_{pc} could be substituted by some length parameter of the quantum orbit. In Chapter 3 of BSM (§3.12.3) it has been shown that the trace length of a quantum orbits is defined by the equation [(3.43.j)].

$$L_q(n) = \frac{2\pi a_o}{n} = \frac{\lambda_c}{n\alpha} = \frac{c}{n\alpha\nu_c} \qquad [(3.43.j)]$$

where: n - is the quantum number, defined by the subharmonic number defining the confined velocity motion of electron in CL space.

For a second subharmonic we have:

$$L_q(2) = 1.66246\times10^{-10} \ [m] \qquad (5.13)$$

This value differs from L_{pc} only by 2%, so L_{pc} in Eq. (5.8) could be substituted. The parameters of the electron: R_c, r_e and r_p can be expressed by the fine structure constant, α, the velocity of light c, and the electron gyromagnetic factor g_e, as shown in §3.6, Chapter 3. Then we arrive to an equation, in which the background temperature is expressed only by the CL space parameters and magnetic moment ratio μ_e/μ_n:

$$T = \frac{N_A^2 hc^2(3g_e\sqrt{1-\alpha^2} + 4\pi\alpha)^3}{864\alpha^3\nu_c^2\pi^2 g_e(1-\alpha^2)R_{ig}}\frac{\mu_e}{\mu_n} \qquad (5.14)$$

The magnetic moment ratio μ_e/μ_n could be also considered defined by the CL space.

The provided analysis is correlated with the calculated mass budget of the proton and cross-validated with the eta-particle mass, and the high energy collision resonances (1.7778 GeV, 1.44 GeV, 80 GeV and 91.18 GeV) (See Chapter 6 of BSM).

5.4. Considerations for breakdown of the equivalence principle at internode range distance.

At first glance it seams that ZPE-D could be estimated if using the classical equation $E = 0.5I\omega^2$, where the moment of inertia, I, could be estimated from the parameters of the oscillating CL node. This equation, however, implies the presumption that the Newtonian gravitational mass is equal to the inertial mass (equivalent principle). Extensive analysis of experiments (not presented here) from a point of view of BSM, however, indicates that equivalence principle breaks down when approaching the internode distance. This is understandable if considering that the CL space could not exercise a static pressure on a particle object whose size is comparable with the internode distance. If the boundary structure of the elementary particle, for example is broken, the internal structure is released as rectangular nodes of six prisms. Such extremely small but superdens particle could not feel the CL pressure and will have an enormous penetration capability. It probably corresponds to one kind of the neutrino particles.

5.5. Hidden space energy

The second type, ZPE-S, is embedded in the connections between the CL nodes. The alternative CL nodes are connected by their abcd axes, in which the SG law is directly involved. In a normal non-disturbed CL space they are well balanced When an elementary particle is immersed, the CL space exercises strong SG forces on its impenetrable volume of the First Order Helical Structures (FOHS). The static energy from this pressure is related to the Newtonian mass by the Einstein equation $E = mc^2$. This pressure called a Static CL pressure is estimated in Chapter 3 by analysis in which the the unveiled structure of the electron is used. Its estimated value is:

$$P_S = 1.3736 \times 10^{26} \ (\mathrm{N}/m)$$ - Static CL pressure

While the obtained value of the Static CL Pressure is very large, one must take into account that it could be exercised only on the volume of the FOHS, since it contains a more dens internal lattice. For the electron, this volume, V_e, is calculated by its identified physical dimensions as a cut toroid with a large radius R_c - (Compton Radius) and a small radius $r_e = 8.8428 \times 10^{-15}(m)$.

$$V_e = 2\pi^2 R_c r_e^2 = 5.96 \times 10^{-40} \ (\mathrm{m}^3)$$

According to the mass equation (3.48) derived in Chapter 3, the mass of electron is:

$$m = (P_S V_e)/c^2 = 9.109 \times 10^{-31} \ (kg)$$

Using Einstein equation $E = mc^2$ we have:

$$E = P_S V_e = 8.187 \times 10^{-14}(J) \equiv 511(KeV)$$

Scaling this energy to 1 cubic meter we obtain the value of ZPE-S energy in system SI:

$$E_S = 1.3736 \times 10^{26} \ (\mathrm{J})$$

How such enormous energy is hidden in space? In fact ZPE-S is composed of two energies related respectively to the left and right-handed CL nodes, which are behind the positive and negative charge. In a non-disturbed CL space, both energies are in accurate balance, so they appear hidden for ordinary EM and gravitational interactions. It is evident from Einstein equation that ZPE-S is accessible if the mass is changed. This in fact is the binding nuclear energy. The energy from the nuclear power stations is a result of changing the nuclear binding energy. This involves a micro-effect of General Relativity, discussed in Chapter 13.

5.5. Summary

The derived expression about the CL space background temperature is a CL space parameter related to the Dynamic type of the ZPE. It corresponds to the estimated blackbody temperature of the Cosmic Microwave Background (CMB).

Eq. (5.8) connects many experimentally measured physical constants. It provides also a relation between the ideal gas constant and the CMB temperature.

The revealed relation between the CMB temperature and ZPE of the CL space, provides a physical meaning of the universal gas constant and the Boltzman constant, as parameters of CL space.

The ZPE-S is the primary source of the nuclear energy. It is directly involved in the definition of the Newtonian mass of the elementary particles.