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Symmetric Theory Omnipresent Medium Planck

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Abstract

In this article, we continue the development of the *Symmetric Theory*. What we will show is the coupling between the universe and the *medium Planck*, understood as the medium that formalises the characteristics of the zero-point field. We will show how the phenomena of the infinitely large of the universe and the infinitely small of the atom harmonize in relation to the *medium Planck*. We will show how Hawking radiation, Unhru effect, Casimir effect, Entropic force, Stefan-Boltzmann's constant, and Wien's displacement law are all phenomena referred to the *medium Planck*. We will show that the electron in the first energy level of the hydrogen atom can never fall into the atomic nucleus because it is supported by the Planck energy through the phenomenon of resonance. What emerges is a new meaning of the fine structure constant, in the sense of coupling constant between the electron and the medium Planck. Finally, a way is indicated that could solve the wave-particle duality.

Subject Areas

Modern Physics

Keywords

Zero-Point Energy, Medium Planck, Superforce, Waking Radiation, Unrhu Effect, Casimir Effect, Entropic Force, Stefan-Boltzmann Constant, Wien's Displacement Law, Fine-Structure Constant, Wave-Particle Duality

1. Introduction

It is amazing how human intelligence has developed an overview of the universe in which we live, managing to provide a structure despite the complexity of the subject. This effort has received the contribution of a whole of humanity, which has individually added pieces to a mosaic that would otherwise be impossible for few people to create. Today, we evaluate our knowledge and move forward thanks to the intuitions of brilliant minds who have opened up gaps where appearances seemed to set insurmountable limits. On the shoulders of these giants, we have broadened our horizons to extremes that were unthinkable a few centuries ago, and their discoveries have become milestones to which we come back whenever science is faced with great dilemmas.

The history of physics is studded with great successes preceded by failed enterprise ventures, which have not prevented the sharpest minds from extrapolating the essentials. Today, our knowledge is well structured in theories that can, in whole or in part, explain the world in which we live.

According to J.D. Barrow [1]: "*science can be identified with the search for algorithmic compressions*", identifying a structure based on the logical meaning (unambiguously) of the principles, axioms, and postulates underlying physical laws.

According to Caldirola [2]: "*theoretical physics, which deals with the construction of theories capable of explaining or describing classes of phenomena, is an intellectual activity by which an attempts is made, by means an appropriate logical-mathematical scheme, to bring order to the variety of physical phenomena… and allows us to explain as many experiments as possible starting from a minimum number of postulates*".

The continuous evolutionary process of increasingly general theories has highlighted that each physical theory is revealed to have a limited field of action. The paradigm shift that has allowed the transition to more general theories has almost always occurred with the discovery of new universal constants—think of the speed of light in a vacuum for the theory of relativity or Planck's constant for quantum mechanics.

Perhaps the most important intuition was to recognize that in nature, there are universal constants, interpreted as *fundamental limitations* [3], not in the sense of insurmountable obstacles but *horizons*, within which our knowledge is enclosed at a given moment. These horizons of reality, which determine current theories, are identified by universal constants or fixed values of some physical observables, which can be interpreted as parameters in the structure of some models or as conversion factors between physical units. It is my belief that the great challenges that await physics pass through the search for their unification.

2. Review Medium Planck

In the development of the *Symmetric Theory* [4], it is argued that the vacuum is the domain of the medium Planck, which operates in the vacuum and characterizes the vacuum, forming a cosmic background to which everything is related and to which we refer our measurements. The medium Planck is characterized by the physical quantities introduced by Planck, which we will recall when we use them. Any physical phenomenon, from our point of view, occurs in relation to the medium Planck.

The crucial feature required by *Symmetric Theory* is that there is a particle capable of satisfying the relationship dictated by the symmetric charge-matter coupling factor

$$Æ \equiv \pm\sqrt{\frac{\varepsilon_o}{G_o}} \approx 8.617\times10^{-11}\left[\frac{\text{C}}{\text{Kg}}\right] \tag{1}$$

capable of making Newton's gravitational force (between masses) and Coulomb's electric force (between electric charges) equal.

The unit system used is the MKS. In the expression (1), ε_o is the dielectric constant of the vacuum and G_o is the gravitational permeability of the vacuum, defined by the relation

$$G_o \equiv \frac{1}{4\pi G} \tag{2}$$

where G is the gravitational constant. In this context, the Planck particle seems to be the only entity able to satisfy the specific relationship imposed by expression (1), the relation being valid

$$\frac{q_P}{m_P} = \pm Æ = \pm\sqrt{\frac{\varepsilon_o}{G_o}} \tag{3}$$

or

$$q_P = \pm Æ\, m_P \tag{4}$$

where m_P is the Planck mass and q_P is the Planck charge. In this context, the Planck particle is identified as a symmetric particle in the sense that it satisfies the *Symmetric Theory*, with double polarity dictated by the sign $\pm$ of formula (4).

From Maxwell's relation in the vacuum

$$c^2 = \frac{1}{\mu_o\,\varepsilon_o} \tag{5}$$

where μ_o is the magnetic permeability of the vacuum, and taking into account relation (1), we obtain

$$c^2 = \frac{1}{Æ^2\, G_o\,\mu_o} = \frac{m_P}{q_P\, G_o\,\mu_o} \tag{6}$$

creating both a quantitative and qualitative connection—so without loss of accuracy—between electromagnetism and gravitation.
Assuming that the Planck particle has a speed equal to the speed of light in a vacuum c, we assumed that the Planck particle has a magnetic charge

$$g_P \equiv q_P\, c\,\mu_o \tag{7}$$

If all these hypotheses were true, we would have the following electro-gravito-magnetic unification at the scale of the medium Planck,

$$\underbrace{\left[F_e = \frac{1}{4\pi\varepsilon_o}\frac{q_P^2}{\ell_P^2}\right]}_{electric} = \underbrace{\left[F_g \equiv \frac{1}{4\pi G_o}\frac{m_P^2}{\ell_P^2}\right]}_{gravitational} = \underbrace{\left[F_m = \frac{1}{4\pi\mu_o}\frac{g_P^2}{\ell_P^2}\right]}_{magnetic} = F_P = \frac{c^4}{G} \tag{8}$$

with F_P the Planck force, which is indicated in the scientific literature as the maximum force or super force [5]-[8].

From the definitions of Planck units and from what we have obtained so far, we have derived the following relations:

$$m_P \equiv \sqrt{4\pi G_o \hbar c} \tag{9}$$

$$q_P \equiv \sqrt{4\pi \varepsilon_o \hbar c} \tag{10}$$

$$g_P \equiv \sqrt{4\pi \mu_o \hbar c} \tag{11}$$

From these, we obtain the following relations:

$$\hbar c \equiv \frac{m_P^2}{4\pi G_o} \equiv \frac{q_P^2}{4\pi \varepsilon_o} \equiv \frac{g_P^2}{4\pi \mu_o} \tag{12}$$

$$\hbar \equiv \frac{m_P^2}{4\pi G_o c} \equiv \frac{q_P^2}{4\pi \varepsilon_o c} \equiv \frac{g_P^2}{4\pi \mu_o c} \tag{13}$$

The relations (12) and (13) indicate that Planck's constant is not limited by the pure definition of quantum of action. In particular, the relation (12) can be considered as a scaling parameter that makes possible the passage between the three characteristic forces and their unification through the following fundamental relation:

$$F_P \equiv \frac{\hbar c}{\ell_P^2} = \frac{c^4}{G} \tag{14}$$

replacing $\hbar c$ the relative value of the relations (12), depending on the physical behaviour of the system under study.

The fine structure constant was first introduced by Sommerfeld [9] to explain—in relation to the electron in its first stationary orbit—the fine structure in the hydrogen atom as the ratio of the velocity of the electron to the velocity of light in the vacuum. In its best-known form, it can be written as:

$$\alpha = \frac{e^2}{4\pi \varepsilon_o \hbar c} \tag{15}$$

where e is the charge of the electron. By squaring the relation (10) and inserting it into the formula (15), we can write

$$\alpha = \frac{e^2}{4\pi \varepsilon_o \hbar c} = \frac{e^2}{q_P^2} \tag{16}$$

Another important aspect is that relation (16) also expresses the ratio between (a) the Coulomb force F_e between two electrons placed at a distance equal to the Planck length ℓ_P, and (b) the Planck force F_P:

$$\alpha = \frac{e^2}{4\pi \varepsilon_o (\hbar c)} = \frac{e^2}{4\pi \varepsilon_o \ell_P^2 \left(\frac{q_P^2}{4\pi \varepsilon_o \ell_P^2} \right)} = \frac{\frac{e^2}{4\pi \varepsilon_o \ell_P^2}}{\frac{q_P^2}{4\pi \varepsilon_o \ell_P^2}} = \frac{F_e}{F_P} = \frac{F_e}{\left(c^4 / G \right)} \tag{17}$$

Furthermore, from formula (15) we obtain:

$$\hbar c \alpha = \frac{e^2}{4\pi\varepsilon_o} \tag{18}$$

In analogy to the (electromagnetic) fine structure constant α, we have introduced the gravitational fine structure constant

$$\alpha_G \equiv \frac{m_e^2}{m_P^2} \equiv \frac{G m_e^2}{\hbar c} \equiv \frac{G m_e^2}{G m_p^2} \equiv \frac{m_e^2}{4\pi G_o \hbar c} \tag{19}$$

where m_e is the mass of the electron and m_P is the Planck mass, and the magnetic fine structure constant,

$$\alpha_M \equiv \frac{g_e^2}{g_P^2} \equiv \frac{g_e^2}{4\pi \mu_o \hbar c} \tag{20}$$

where g_e indicates the magnetic monopole of the electron and g_P the magnetic monopole of the Planck particle.

In order to verify whether the electron follows a symmetric coupling relation, analogous to the behavior of the Planck particle, we hypothesized the validity of the following properties of the electron:

$$e \equiv \beta m_e \tag{21}$$

where m_e is the mass of the electron, e is the electric charge of the electron and β is an unknown constant capable of maintaining the specific ratio $\beta = e/m_e$. From the coupling constant α, and using equations (16) and (20), we obtain:

$$\alpha = \frac{e^2}{q_p^2} = \frac{\beta^2 m_e^2}{Æ^2 m_p^2} = \frac{\beta^2}{Æ^2}\alpha_G \tag{22}$$

where the relation (4) was used, from which we obtain:

$$\beta^2 \equiv \frac{\alpha Æ^2}{\alpha_G} \rightarrow \beta \equiv \pm Æ\sqrt{\frac{\alpha}{\alpha_G}} \tag{23}$$

Numerically we get

$$\beta \approx \pm 1.759 \times 10^{11} \tag{24}$$

which is exactly equal to the specific ratio e/m_e of the electron

$$\frac{e}{m_e} \approx 1.758 \times 10^{11} \tag{25}$$

It has also been pointed out that the Planck force appears in the formulation of general relativity, in Einstein's field equations [10],

$$G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = \kappa T_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \tag{26}$$

where $G_{\mu\nu}$ is the curvature tensor and $T_{\mu\nu}$ is the energy-momentum density tensor. Substituting formula (14) into formula (26), we obtain

$$G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = 8\pi\left(\frac{\ell_P^2}{\hbar c}\right) T_{\mu\nu} \tag{27}$$

where Planck's constant is introduced naturally into general relativity without any loss of accuracy.

In the paper [11], we considered the following relations for the medium Planck:

$$k_B T_P = k_B \sqrt{\frac{\hbar c^5}{G k_B^2}} = \sqrt{k_B^2 \frac{\hbar c^5}{G k_B^2}} = \sqrt{\frac{\hbar c^5}{G}} \tag{28}$$

where k_B is the Boltzmann constant and T_P is the Planck temperature;

$$m_P c^2 = \sqrt{\frac{\hbar c}{G}} c^2 = \sqrt{c^4 \frac{\hbar c}{G}} = \sqrt{\frac{\hbar c^5}{G}} \tag{29}$$

where m_P is the Planck mass and c is the speed of electromagnetic waves in the vacuum;

$$\hbar \omega_P = h \nu_P = \hbar \sqrt{\frac{c^5}{\hbar G}} = \sqrt{\hbar^2 \frac{c^5}{\hbar G}} = \sqrt{\frac{\hbar c^5}{G}} \tag{30}$$

where $\hbar$ is the reduced Planck constant, ω_P the Planck angular frequency and ν_P is the Planck frequency.

As a result, the three expressions (28), (29), (30) are equal to each other and equal to the Planck energy

$$E_P = h \nu_P = \hbar \omega_P = k_B T_P = m_p c^2 = \sqrt{\frac{\hbar c^5}{G}} \tag{31}$$

We can then combine equations (28), (29), and (30) into a single energy relation that is valid both quantitatively and qualitatively,

$$\underbrace{k_B T_P}_{thermal} = \underbrace{m_p c^2}_{particle} = \underbrace{h \nu_P}_{wave} \tag{32}$$

as evidence of the energetic unification of the medium Planck.

Finally, from thermodynamic considerations and the standard Big Bang model, we hypothesized that the medium Planck could represent the perfect (ideal) gas invoked by thermodynamics, deducing that k_B represents the Planck entropy $S_P = k_B$, and as a consequence, the entropy quantum. The medium Planck perfectly verifies the equation of state of the perfect gas

$$p_P V_P = n R T_P \tag{33}$$

where p_P is the Planck pressure, V_P is the Planck volume, n is the number of moles, R is the gas constant. Furthermore, the gas constant represents the entropy of one mole of medium Planck:

$$R = N_A k_B = 8.31451 \left[\frac{\text{J}}{\text{mole} \cdot \text{K}} \right] \tag{34}$$

3. Lattice Planck

We now want to determine what is the distribution in the space of the medium Planck that satisfies the equation of state expressed by formula (33). Let us suppose that a mole formed by N_A (Avogrado number) Planck particles occupies a volume υ, so that, considering υ_o the volume of each single Planck particle, the following relation is respected

$$\upsilon = N_A \upsilon_o \tag{35}$$

We have no information on either υ_o or υ, so we have to make some assumptions. Let us assume that the volume of each single Planck particle is equal to the cubic Planck volume $\upsilon_o = V_P = \ell_P^3$, with

$$\upsilon_o = V_P = \ell_P^3 = \left(\sqrt{\frac{\hbar G}{c^3}}\right)^3 \tag{36}$$

Using the formula (36), the formula (35) becomes:

$$\upsilon \equiv N_A \upsilon_o = N_A \left(\sqrt{\frac{\hbar G}{c^3}}\right)^3 = N_A \frac{\hbar G}{c^4}\sqrt{\frac{\hbar G}{c}} \tag{37}$$

Noting that the Planck force is $F_P = \frac{c^4}{G}$, and that $m_P = \sqrt{\frac{\hbar G}{c}}$, (37) can also be rewritten as

$$\upsilon = N_A \upsilon_o \equiv N_A \frac{\hbar}{F_P} m_P \tag{38}$$

which represents the volume of one mole of medium Planck.

The equation of state of ideal gases, for one mole, $n = 1$, or for a number of particles $N = N_A$, applied to the medium Planck, becomes:

$$p_P V_P = n R T_P \quad \rightarrow \quad V_P = R \frac{T_P}{p_P} \tag{39}$$

Taking into account the relation (34) from the expression (39), we obtain:

$$V_P = N_A k_B \frac{T_P}{p_P} \tag{40}$$

For the medium Planck, we have:

$$p_P = \frac{F_P}{\ell_P^2} = \frac{c^7}{\hbar G^2} \tag{41}$$

$$T_P = \sqrt{\frac{\hbar c^5}{G k_B^2}} \tag{42}$$

from which the ratio is obtained

$$\frac{T_P}{p_P} = \frac{\sqrt{\frac{\hbar c^5}{G k_B^2}}}{\frac{c^7}{\hbar G^2}} = \frac{\frac{c^2}{k_B}\sqrt{\frac{\hbar c}{G}}}{\frac{c^7}{\hbar G^2}} = \frac{c^2}{k_B}\sqrt{\frac{\hbar c}{G}}\frac{\hbar G^2}{c^7} = \sqrt{\frac{\hbar c}{G}}\frac{\hbar G^2}{c^5} \tag{43}$$

From the formula (40), we obtain that the volume occupied by one mole (N_A particles) of the medium Planck is

$$V_P = N_A k_B \frac{T_P}{p_P} = N_A k_B \sqrt{\frac{\hbar c}{G}} \frac{\hbar G^2}{k_B c^5} = N_A \frac{\hbar G^2}{c^5}\sqrt{\frac{\hbar c}{G}} \tag{44}$$

From the comparison with the expression (37), we have the equivalence

$$V_P = \upsilon = N_A\,\upsilon_o \quad \rightarrow \quad V_P = N_A\,k_B\,\frac{T_P}{p_P} \tag{45}$$

Thus, the cubic volume of the single Planck particle satisfies the equation for the state of ideal gases. This allows us to assume that *the distribution of the Planck medium is a cubic lattice*.

If instead we assume that υ_o it is the volume of a sphere of radius ℓ_P, we would have $\upsilon_o = \frac{4}{3}\pi\ell_P^3$, and the result would be different:

$$\upsilon = N_A\frac{4}{3}\pi\,\ell_P^3 = N_A\frac{4}{3}\pi\left(\sqrt{\frac{\hbar\,G}{c^3}}\right)^3 = \left(\frac{4}{3}\pi\right)N_A\frac{\hbar\,G}{c^4}\sqrt{\frac{\hbar\,G}{c}} \tag{46}$$

not verifying the equation of the state of ideal gases expressed by formula (33).

4. Omnipresent Medium Planck

4.1. Hawking Radiation—Unhru Effect

When a star of early formation has exhausted all its nuclear fuel (hydrogen), it is no longer able to sustain its self-gravitation, collapsing under the effect of its own mass. At the beginning of the collapse, the star transforms into a white dwarf with a characteristic matter density of the order of $\rho \geq 10^5$ g/cm^3. At this stage, the electrons are no longer bound to the atomic nucleus and can be modeled as a Fermi gas of electrons, which obeys the Pauli exclusion principle. In this scenario, pressure is created towards the outside of the star to try to stop the gravitational collapse. However, there is an upper limit to this pressure. If the mass of the collapsing star exceeds the critical value of 1.44 solar masses (Chandrasekhar limit) [12], this pressure is no longer able to stop the collapse.

A star with a mass greater than the Chandrasekhar limit will continue to collapse until it reaches the consistency of a neutron star, with a matter density of the order of $\rho \geq 10^{13}$ g/cm^3. At this regime, another pressure mechanism towards the outside of the star is triggered, provided by the Fermi gas of neutrons.

Oppenheimer and Volkoff [13] showed that if the mass of a neutron star exceeds a certain critical mass of about 0.7 solar masses, the collapse can no longer be stopped, and the star collapses completely, transforming into a black hole. The radius of the collapsed star reaches the critical value of the Schwarzschild radius [14]

$$R_S = \frac{2\,M\,G}{c^2} \tag{47}$$

where G is the gravitational constant, c is the speed of light and M is the mass of the black hole. After reaching the Schwarzschild radius, the star continues to collapse into a region where the gravitational effects are so strong that not even light can escape. Hence the name black hole. Eventually, the interior of the black hole collapses into a singularity (theoretical prediction), meaning the star is compressed into a singular point in space.

The thermodynamic investigation of gravity originates from the works of Hawking [15] and Bekenstein [16] and from the study of black hole thermodynamics. Later, Jacobson [17] demonstrated that Einstein's field equations can be derived from general thermodynamic considerations combined with the equivalence principle. Some physicists have also been involved in exploring the connections between gravity and entropy, including Padmanabhan [18].

Hawking showed that a black hole emits thermal radiation with the spectrum of a black body. This implies that a black hole has thermodynamic properties, including entropy. Bekenstein had already proposed the existence of black hole entropy, and Hawking was able to confirm Bekenstein's conjecture, obtaining the entropy of a black hole in the form

$$S_H = \frac{1}{4}\frac{k_B c^3}{\hbar G} A \quad (48)$$

where A is the area of the event horizon, with a temperature of the blackbody radiation given by the Hawking temperature

$$T_H = \frac{\hbar c^3}{8\pi G k_B M} \quad (49)$$

Now, if we analyze from the point of view of the medium Planck the equation (48), that is, the Hawking-Bekenstein entropy, knowing that the Planck length is $\ell_P = \sqrt{\frac{\hbar G}{c^3}}$, we obtain

$$S_H = \frac{1}{4} k_B \frac{A}{\ell_P^2} \quad (50)$$

This result tells us that the Hawking-Bekenstein entropy is related to the Planck entropy $S_P = k_B$, with a proportionality A/ℓ_P^2, where A is the area of the black hole event horizon. The important aspect is that the Hawking-Bekenstein entropy is A/ℓ_P^2 times the entropy quantum k_B. In a lattice structure, such as the one we are hypothesizing, the ratio A/ℓ_P^2 expresses the number of Planck particles contained in the area A of the black hole event horizon.

Similar considerations can be made for the Hawking temperature (49), first by transforming it into an energy equation:

$$k_B T_H = \frac{\hbar c^3}{8\pi G M} \quad (51)$$

Since we know that $m_P c = \sqrt{\frac{\hbar c^3}{G}}$, we get:

$$k_B T_H = \frac{m_P^2 c^2}{8\pi M} \quad (52)$$

By multiplying the numerator and denominator of the relation (52) by c^2, we have

$$k_B T_H = \frac{m_P^2 c^4}{8\pi M c^2} \quad (53)$$

Since $m_P c^2 = E_P$ represents the Planck energy, while $M c^2 = E_{BB}$ represents the black hole energy, we can write

$$k_B T_H = \frac{E_P^2}{8\pi E_{BB}} \tag{54}$$

This expression is dimensionally correct since on the left side, we have an energy $\left(k_B T_H\right)$, while on the right side, we have the ratio between an energy squared and an energy $\left(E_P^2 / E_{BB}\right)$. So, ultimately, we can write

$$T_H = \frac{E_P^2}{8\pi k_B E_{BB}} \tag{55}$$

If we consider the gravitational acceleration at the surface of the black hole,

$$g_{BB} = \frac{G M_{BB}}{R_S^2} \tag{56}$$

and substitute R_S into the equation (47), we get

$$g_{BB} = \frac{G M_{BB}}{\left(\frac{2 M_{BB} G}{c^2}\right)^2} = G M_{BB}\left(\frac{c^4}{4 M_{BB}^2 G^2}\right) = \frac{c^4}{4 G M_{BB}} \tag{57}$$

In this expression, the Planck force is evident $F_P = c^4/G$, and therefore

$$g_{BB} = \frac{1}{4}\frac{F_P}{M_{BB}} \tag{58}$$

or

$$M_{BB}\, g_{BB} = \frac{1}{4} F_P \tag{59}$$

which shows us the relationship between the black hole force $F_{BB} = M_{BB}\, g_{BB}$ and the Planck force F_P.

If we multiply and divide the expression (49) by c, we get:

$$T_H = \frac{\hbar c^4}{8\pi G k_B c M} = \frac{\hbar}{2\pi k_B c}\frac{c^4}{4GM} \tag{60}$$

and by considering the expression (57), finally, we obtain:

$$T_H = \frac{\hbar g}{2\pi k_B c} \tag{61}$$

where g is the gravitational acceleration at the surface of the black hole, k_B is the Boltzmann's constant, and c is the speed of light in the vacuum. What is interesting to add after having transformed expression (49) into expression (61).

Davies [19] and Unruh [20], separately, have shown that a detector uniformly accelerated in vacuum responds as if immersed in a thermal field of temperature

$$T_{D-U} = \frac{\hbar a}{2\pi k_B c} \tag{62}$$

where a is the acceleration in the instantaneous rest frame of the detector. Thus, the Hawking temperature is a particular case of the Davies-Unruh temperature with $a = g$.

4.2. Entropic Force

The Equation (8) shows that the Planck particle is in the gravitational-electromagnetic unification condition. Furthermore, it has been shown [4] that the Planck force and the Planck energy are related by the equivalence "energy = work":

$$F_P \, \ell_P \equiv E_P \tag{63}$$

from which it is obtained

$$F_P \equiv \frac{E_P}{\ell_P} \tag{64}$$

Remembering that $\ell_P \equiv \sqrt{\frac{\hbar G}{c^3}} \equiv \frac{\hbar}{m_P c}$, the formula (64) can be rewritten as

$$F_P \equiv \frac{E_P}{\frac{\hbar}{m_P c}} = \frac{m_P c}{\hbar} E_P \tag{65}$$

If we substitute $E_P = k_B T_P$, obtained from the relation (31), we obtain

$$F_P \equiv \frac{m_P c}{\hbar} k_B T_P \tag{66}$$

which we define as *Planck's entropic force*, very similar to the definition of *entropic force* in relation to entropic gravity [21].

The Planck entropic force is also defined by the expression:

$$F_P \equiv \frac{T_P S_P}{\ell_P} \tag{67}$$

In fact, if, as we assumed, the Planck entropy is $S_P = k_B$, substituting in the expression (67), we obtain

$$F_P = \frac{k_B T_P}{\ell_P} \tag{68}$$

Since $E_P = k_B T_P$, the Equation (68) returns to the form of (64).

But we can go further if we replace the Planck energy with the relation $E_P = \hbar \omega_P$, obtaining

$$F_P \equiv \frac{m_P c}{\hbar} \hbar \omega_P \equiv m_P c \, \omega_P \tag{69}$$

Or, if we substitute the relation $E_P = m_P c^2$, we get

$$F_P \equiv \frac{m_P c}{\hbar} m_P c^2 \equiv \frac{m_P^2 c^3}{\hbar} \tag{70}$$

4.3. Casimir Effect

In February 1911, Planck presented the hypothesis [22] that oscillating dipoles, in addition to the energy

$$E = \frac{h\nu}{e^{\frac{h\nu}{k_B T}} - 1} \tag{71}$$

they can have an additional energy equal to $\frac{1}{2}h\nu$, independent of the temperature:

$$E = \frac{h\nu}{e^{\frac{h\nu}{k_B T}} - 1} + \frac{1}{2}h\nu \tag{72}$$

While the first term disappears in the limit $T \to o$, the second term, the zero-point energy, persists even at absolute zero temperature. Planck's presentation in 1911 has taken on an extraordinary significance since, for the first time, unequivocally—even before the formulation of quantum mechanics—the possibility of a zero-point energy is formulated. Planck demonstrated that his radiation law was compatible with the zero-point energy, which instead was postulated 15 years later by quantum mechanics.

In the presentation of the new formula, Planck clearly states that it is not easy to confirm or disprove the existence of zero-point energy through experiments, since it cannot be isolated. But, in May 1948, Casimir [23] provided a brilliant idea to lock part of the zero-point energy in a certain volume by means of limitations and thus make it observable.

The Casimir effect is the force acting between two uncharged parallel plates, usually attributed to the change in the zero-point energy of the electromagnetic vacuum between the plates, compared to the zero-point energy in the vacuum in the same region in the absence of constraints. This energy is not directly observable, but is related to the Casimir force between the plates that pushes them together. The Casimir effect is generally regarded as evidence for the reality of zero-point energy.

The pressure acting between the planes, provided by Casimir, is given by the following expression

$$\frac{F_{cas}}{A} = \frac{\hbar c \pi^2}{240 d^4} \tag{73}$$

where A is the area of the planes, d is the distance separating them, and the factor 240 comes from physical and analytical considerations. Since we know that $F_P = \frac{\hbar c}{\ell_P^2}$, we define the Planck pressure as:

$$P_P \equiv \frac{F_P}{\ell_P^2} \equiv \frac{\hbar c}{\ell_P^4} \tag{74}$$

from which it is obtained

$$\hbar c = P_P \ell_P^4 \tag{75}$$

So the pressure exerted by the Casimir effect—formula (73)—becomes:

$$\frac{F_{cas}}{A} = P_P \ell_P^4 \frac{\pi^2}{240 d^4} = \frac{P_P}{\left(\frac{d}{\ell_P}\right)^4} \frac{\pi^2}{240} \tag{76}$$

from which the Casimir force can be obtained:

$$F_{cas} = \frac{P_P}{\left(\frac{d}{\ell_P}\right)^4} \frac{\pi^2}{240} A \tag{77}$$

By using the first equality of expression (74), we have

$$F_{cas} = \frac{\left(\frac{F_P}{\ell_P^2}\right)}{\left(\frac{d}{\ell_P}\right)^4} \frac{\pi^2}{240} A \tag{78}$$

and by arranging better, you can write

$$F_{cas} = \frac{F_P}{\left(\frac{d}{\ell_P}\right)^4} \frac{\pi^2}{240} \left(\frac{A}{\ell_P^2}\right) \tag{79}$$

We now have complete dependence on the Casimir force with respect to the medium Planck.

However, it is interesting to note the different dependence of the Casimir force. The expression (77) depends on the Planck pressure, and the expression (79) depends on the Planck force. Both formulations have the same dependence of the type $\left(d/\ell_P\right)^4$ with respect to the direction of separation between the planes, but in formula (77), the dependence on the term does not appear, and therefore, from our point of view, formula (79) it should be considered more complete.

4.4. Stefan-Boltzmann Costant

As we know, for Planck [22], the average energy of each oscillator is given by the expression

$$\langle E \rangle = \frac{h\nu}{e^{\frac{h\nu}{k_B T}} - 1} \tag{80}$$

or in terms of wavelength

$$\langle E \rangle = \frac{hc/\lambda}{e^{\frac{hc}{\lambda k_B T}} - 1} \tag{81}$$

Furthermore, the energy density in the range $[\lambda, \lambda + \mathrm{d}\lambda]$, is

$$\rho(\lambda, T)\mathrm{d}\lambda = \frac{8\pi hc}{\lambda^5} \frac{1}{e^{\frac{hc}{\lambda k_B T}} - 1} \mathrm{d}\lambda \tag{82}$$

or in terms of frequency, in the frequency range $[\nu, \nu + \mathrm{d}\nu]$:

$$\rho(\nu, T)\mathrm{d}\nu = \frac{8\pi\nu^2}{c^3} \frac{h\nu}{e^{\frac{h\nu}{k_B T}} - 1} \mathrm{d}\nu \tag{83}$$

Inside the blackbody, the total energy density is defined by

$$U = \int_o^\infty \rho(\nu, T)\,\mathrm{d}\nu \tag{84}$$

To calculate the integral (84), we perform the substitution of variables $x = \frac{h\nu}{k_B T}$, obtaining:

$$U = \frac{8\pi}{c^3}\int_o^\infty \frac{h\nu^3}{e^{\frac{h\nu}{k_B T}} - 1}\frac{k_B T}{h}\mathrm{d}\nu = \frac{8\pi}{c^3}\int_o^\infty \frac{\nu^3}{e^x - 1}k_B T\,\mathrm{d}x \quad (85)$$

After some algebra, the integral (85) takes the form:

$$U = \frac{8\pi}{c^3}\int_o^\infty \frac{\left(\frac{k_B T}{h}x\right)^3}{e^x - 1}k_B T\,\mathrm{d}x = \frac{8\pi}{c^3}\frac{k_B^4 T^4}{h^3}\int_o^\infty \frac{x^3}{e^x - 1}\mathrm{d}x \quad (86)$$

Since the integral is

$$\int_o^\infty \frac{x^3}{e^x - 1}\mathrm{d}x = \frac{\pi^4}{15} \quad (87)$$

finally, we have the Stefan-Boltzmann law [24]-[26]

$$U = \left(\frac{8\pi^5 k_B^4}{15h^3c^3}\right)T^4 = aT^4 \quad (88)$$

with

$$a = \frac{8\pi^5 k_B^4}{15h^3c^3} \quad (89)$$

or, we can also write

$$a = \frac{8\pi^5 k_B^4}{15h^3c^3} = \frac{8\pi^5 k_B^4}{15(2\pi\hbar)^3 c^3} = \frac{\pi^2 k_B^4}{15\hbar^3 c^3} \quad (90)$$

So, the expression (88) becomes:

$$U = \frac{\pi^2 k_B^4 T^4}{15\hbar^3 c^3} \quad (91)$$

The product of the Planck energy and the Planck length is

$$E_P \ell_P = m_P c^2 \frac{\hbar}{m_P c} = \hbar c \quad (92)$$

We also know that the Planck energy is equal to $E_P = k_B T_P$, and indicating with $E_{BB} = k_B T$ the black body energy, the expression (91) can be written as:

$$U = \left(\frac{\pi^2}{15}\right)\frac{k_B^4 T^4}{\hbar^3 c^3} = \left(\frac{\pi^2}{15}\right)\frac{E_{BB}^4}{E_P^3 \ell_P^3} \quad (93)$$

This expression is dimensionally correct, as the ratio E_{BB}^4 / E_P^3 represents the relative energy of the blackbody with respect to the medium Planck, divided by the Planck volume ℓ_P^3.

4.5. Wien's Displacement Law

From the law (82), the energy density $\rho(\lambda, T)$ is maximum for a certain value $\tilde{\lambda}$, which is obtained by maximizing the derivative of $\rho(\lambda, T)$ with respect to λ:

$$\frac{\mathrm{d}\rho(\lambda,T)}{\mathrm{d}\lambda}=o \tag{94}$$

The final result, after making the substitution $x=\frac{hc}{\lambda k_B T}$, leads to the following transcendental equation

$$x=\ln 5-\ln(5-x) \tag{95}$$

which admits two solutions:

$$x_o=\frac{hc}{\tilde{\lambda}k_B T}=o \quad \text{e} \quad \tilde{x}=\frac{hc}{\tilde{\lambda}k_B T}\approx 4.965 \tag{96}$$

The solution $x_o=\frac{hc}{\tilde{\lambda}k_B T}=o$ involves two possibilities:

1) $\hbar c=o$. Since $\hbar c\approx(1.0545\times10^{-34})\cdot(3\times10^{8})\approx 3.1635\times10^{-26}\approx o$ it is good, but it does not lead to further useful information, except when $\hbar\to o$ it is at the limit of the continuum.

2) Or that the denominator is of much higher order than the numerator, that is

$$\tilde{\lambda}\,k_B T\gg hc. \tag{97}$$

it can also be written as

$$k_B T\gg\frac{hc}{\tilde{\lambda}} \quad\to\quad k_B T\gg h\tilde{\nu} \tag{98}$$

Before continuing, it is necessary to point out that from the energy relation (32), we obtain the ratio

$$\frac{h}{k_B}=\frac{T_P}{\nu_P} \tag{99}$$

Therefore, the expression (97) becomes

$$\frac{T}{\tilde{\nu}}\gg\frac{h}{k_B}=\frac{T_P}{\nu_P} \tag{100}$$

So, this second option represents a particular condition that we will deal with in another article (in preparation) about the Planck spectrum.

In the scientific literature, only the solution $\tilde{x}$ is given, which leads to Wien's displacement law [26] [27]:

$$\tilde{\lambda}T\approx\frac{hc}{k_B\tilde{x}} \tag{101}$$

where $\tilde{\lambda}=\lambda_{\max}$. This expression, by using the relation (99), and better arranged, can be written as

$$\tilde{\lambda}T=\frac{1}{\tilde{x}}\left(\frac{h}{k_B}\right)c=\frac{1}{\tilde{x}}\left(\frac{T_P}{\nu_P}\right)c=\frac{T_P}{\tilde{x}}\left(\frac{c}{\nu_P}\right) \tag{102}$$

and since $\frac{c}{\nu_P}=\lambda_P$, ultimately, we have

$$\tilde{\lambda}\,T=\frac{T_P\,\lambda_P}{\tilde{x}} \tag{103}$$

or in terms of frequencies

$$\frac{T}{\tilde{\nu}} = \frac{1}{\tilde{x}}\left(\frac{T_P}{\nu_P}\right) \tag{104}$$

The expression (103) already shows the relation between the black body and the medium Planck.

To explain it better, we point out that,

$$h\,c = E_P\,\ell_P \tag{105}$$

from which

$$\tilde{x} = \frac{h\,c}{\tilde{\lambda}\,k_B T} = \frac{E_P\,\ell_P}{\tilde{\lambda}\,k_B T} = \frac{E_P}{k_B T}\frac{\ell_P}{\tilde{\lambda}} \tag{106}$$

and since $\tilde{\lambda} = 2\pi\tilde{\ell}$, $E_{BB} = k_B\,T$, finally, we have

$$\tilde{x} = \frac{E_P}{E_{BB}}\frac{\ell_P}{2\pi\tilde{\ell}} \tag{107}$$

In practice, $\tilde{x}$ it is a pure number expressed by an energy ratio.

Finally, we note that the expression (101) has the same form as the de Broglie thermal wavelength.

$$\lambda_{term} \approx \frac{1}{\tilde{x}}\frac{hc}{k_B\,T} \tag{108}$$

5. Resonances—Fiat Electron

It is well established that the study of atomic physics requires the application of quantum mechanics. In this section, we are not interested in reviewing the largely well-developed atomic model, but we want to ask ourselves the same question that Nernst asked himself at the beginning of 1916 [28]: *How can the electron be in constant radiation, but the atom remains stable*? And we add: *Why can the atomic electron perform any transition between two energy levels, but can never go below the ground state, spiraling toward the nucleus*? The answer of a modern physicist would be—without a doubt—because it is forbidden by quantum mechanics and its uncertainty principle.

However, since we are interested in the electron in the ground state, and the Bohr atomic model of 1913 [29], at this level, offers the same solutions as quantum mechanics without further limitations, then we will use this model, which turns out to be correct for a one-electron atom.

By ignoring the action of the magnetic field on the electronic charge, which is negligible for our purposes, and neglecting the effect of the reduced mass obtained by considering the mass of the nucleus, which is also negligible in this case but important for isotopes, in the Bohr atomic model the centripetal repulsion is balanced by the attraction of the Coulomb electric force:

$$m_e\frac{\mathrm{V}_B^2}{r_B} = \frac{e^2}{4\pi\varepsilon_o\,r_B^2} \tag{109}$$

This approach starts from the assumption that the electron is already in the equilibrium configuration, but before this happens, the electron must be captured by the nucleus, which brings it into this configuration. Therefore, the electron can be in any position with any speed, but once captured, it must be in dynamic conditions such as to respect the equivalence (109). As an example, we can consider a conduction electron in motion in a conductor, which, at the moment of atomic capture, goes to position itself in an energy state allowed by the atomic structure of the metal. After the capture, the electron must obey the laws of atomic physics. If the electron is captured by a hydrogen ion, the dynamic condition that is seen in nature is equality (109), which is the first dynamic condition to be respected, and this configuration is preparatory to all the others.

This configuration is, for Bohr, a necessary condition to have the electron in stationary orbits without radiation. If one takes into account the emission of energy by radiation (as predicted by electrodynamics for an accelerated electric charge), for an initial circular orbit with $r = 0.5$ Å, it can be shown that $r \to o$ in about 1.3 × 10^{-11} s [30], and the radiated energy, of the order of 10^5 eV, would be much larger than that normally emitted by atoms, of the order of 10 eV. For Bohr, this behavior does not reflect an atomic system. In nature, atoms in their permanent state (this is what Bohr calls the energy state) have fixed dimensions and frequencies. In the article, Bohr assumes that an electron, at a very large distance from the nucleus and with negligible velocity, due to the interaction with the nucleus, ends up in a stationary orbit. Therefore, the more precise question, compared to the one formulated at the beginning of this section, would be: *Why exactly is the configuration imposed by the ground state* (109)? What we will try to show is why this condition occurs. What we will try to show is why this condition occurs.

Indeed, the electron, even in its stationary orbit, does not perform a circular orbit but an orbit with fluctuations back and forth toward the nucleus. However, for what concerns us, we can consider orbits that are, on average, circular.

After simple calculations from the equivalence (109), we obtain

$$m_e \mathrm{V}_B^2 r_B = \frac{e^2}{4\pi\varepsilon_o} \tag{110}$$

where m_e is the mass of the electron, V_B is the velocity of the electron in the ground state, r_B is the radius of the circular orbit (also called a_o), e is the charge of the electron. Since, for Bohr, the angular momentum in the first orbit is $m_e \mathrm{V}_B r_B = \hbar$, we can continue as follows

$$\underbrace{m_e \mathrm{V}_B r_B}_{\hbar} \mathrm{V}_B = \hbar \mathrm{V}_B = \frac{e^2}{4\pi\varepsilon_o} \tag{111}$$

and since $\mathrm{V}_B = \omega_B r_B$, by substituting, we get

$$\hbar \omega_B r_B = \frac{e^2}{4\pi\varepsilon_o} \tag{112}$$

that is

$$\hbar\omega_B = h\nu_B = -\frac{e^2}{4\pi\varepsilon_o r_B} \tag{113}$$

where ω_B is the orbital angular frequency, ν_B is the orbital frequency, and the minus sign has been inserted because, for any bound system, the potential energy is negative. The formula (113) expresses the potential energy of the ground state of the atomic electron, which is equivalent to the energy of a photon with a frequency equal to the orbital frequency of the ground state of the electron.

Furthermore, from the formula (109), we obtain

$$m_e \mathrm{V}_B^2 = \frac{e^2}{4\pi\varepsilon_o r_B} \tag{114}$$

from which follows

$$\frac{1}{2} m_e \mathrm{V}_B^2 = \frac{1}{2}\left(\frac{e^2}{4\pi\varepsilon_o r_B}\right) \tag{115}$$

which represents the kinetic energy of the electron in the ground state, which, by the Virial theorem, is half of the potential energy.

Ultimately, the energy of the electron in the ground state, as the sum of the kinetic energy of rotation and the potential energy of binding, is equal to:

$$E_1 = \frac{1}{2}\left(\frac{e^2}{4\pi\varepsilon_o r_B}\right) - \frac{e^2}{4\pi\varepsilon_o r_B} = \frac{-e^2}{8\pi\varepsilon_o r_B} \tag{116}$$

and by taking into account the relation (113), we can conclude that

$$E_1 = -\frac{e^2}{8\pi\varepsilon_o r_B} = -\frac{1}{2} h\nu_B \tag{117}$$

This relationship is correct both quantitatively and qualitatively. In fact,

$$E_1 = \frac{e^2}{8\pi\varepsilon_o r_B} = \frac{\left(1.6021\times10^{-19}\right)^2}{8\pi\left(8.8541\times10^{-12}\right)\left(5.292\times10^{-11}\right)} = 2.18\times10^{-18}\ \mathrm{J} \tag{118}$$

$$E_1 = \frac{1}{2} h\nu_B = \frac{1}{2}\left(6.6260\times10^{-34}\right)\left(6.58\times10^{15}\right) = 2.18\times10^{-18}\ \mathrm{J} \tag{119}$$

From the relation (109), we obtain

$$\mathrm{V}_B = \frac{e^2}{4\pi\varepsilon_o \hbar} \tag{120}$$

and dividing by c

$$\frac{\mathrm{V}_B}{c} = \frac{e^2}{4\pi\varepsilon_o \hbar c} \tag{121}$$

which is equal to the expression of the fine structure constant

$$\alpha = \frac{\mathrm{V}_\mathrm{B}}{c} = \frac{e^2}{4\pi\varepsilon_o \hbar c} \tag{122}$$

We note that it is also valid the equivalence

$$E_B = \alpha^2\left(\frac{1}{2}m_e c^2\right) = \frac{1}{2}m_e \mathrm{V}_B^2 \approx \left(\frac{1}{2}\right)\left(9.109\times10^{-31}\right)\left(2.18\times10^{6}\right)^2 \approx 2.18\times10^{-18}\ \mathrm{J} \quad (123)$$

Recall that in the *Symmetric Theory*, as we showed in the paper [11], for an oscillator immersed in the thermal bath of the medium Planck, the same law as Planck's law of the spectrum of a black body is obtained. But from the point of view of *Symmetric theory*, the energy of the ground state of the electron is not at its disposal, since it belongs to the radiation field of the medium Planck.

Now, if we apply an external impulse with a very precise frequency to any oscillating system (harmonic oscillator, dipole, etc.), the action of this force will eventually cause resonance phenomena, allowing the absorption of energy by the oscillating system. This is the clue we need to continue the reasoning stated in this section. We are looking to see if there are resonance phenomena between the electron in the ground state and the medium Planck—which acts as an external force—capable of providing the energy necessary for the electron not to fall into the atomic nucleus. What we will look for are couplings between known atomic quantities with respect to the medium Planck.

To do this, we consider the ratio of the electric potential energy of the medium Planck in the form

$$U_P = \frac{q_P^2}{4\pi\varepsilon_o \ell_P} \approx \frac{\left(1.87\times10^{-18}\right)^2}{4\pi\left(8.8541\times10^{-12}\right)\left(1.6160\times10^{-35}\right)} \approx 1.956\times10^{9}\ \mathrm{J} \quad (124)$$

and the electric potential energy of the electron in the ground state

$$U_B = \frac{e^2}{4\pi\varepsilon_o r_B} \approx \frac{\left(1.6021\times10^{-19}\right)^2}{4\pi\left(8.8541\times10^{-12}\right)\left(5.292\times10^{-11}\right)} \approx 4.359\times10^{-18}\ \mathrm{J} \quad (125)$$

obtaining the result

$$\frac{U_P}{U_B} \approx \frac{\left(1.956\times10^{9}\right)}{4.359\times10^{-18}} \approx 4.487\times10^{26} \quad (126)$$

This numerical ratio, which at first sight seems to provide no information, if analyzed more closely, reveals the following property:

$$\frac{U_P}{U_B} = \frac{\left(\dfrac{q_P^2}{4\pi\varepsilon_o \ell_P}\right)}{\left(\dfrac{e^2}{4\pi\varepsilon_o r_B}\right)} = \left(\frac{q_P^2}{4\pi\varepsilon_o \ell_P}\right)\left(\frac{4\pi\varepsilon_o r_B}{e^2}\right) = \left(\frac{q_P^2}{e^2}\right)\left(\frac{r_B}{\ell_P}\right) = \frac{1}{\alpha}\left(\frac{r_B}{\ell_P}\right) \quad (127)$$

where we have used the property (16) of the fine structure constant. Numerically we have

$$\frac{U_P}{U_B} = \frac{1}{\alpha}\left(\frac{r_B}{\ell_P}\right) \approx (137)\frac{5.292\times10^{-11}}{1.616\times10^{-35}} \approx 4.486\times10^{26} \quad (128)$$

Thus, we have found a coupling between the radius of the first Bohr orbit (ground state) and the Planck length.

Since $\ell_P = \lambda_P/2\pi$ and $r_B = \lambda_B/2\pi$ from the ratio (127), we obtain:

$$\frac{U_P}{U_B} = \frac{1}{\alpha}\left(\frac{\lambda_B}{\lambda_P}\right) \tag{129}$$

and numerically

$$\frac{1}{\alpha}\left(\frac{\lambda_B}{\lambda_P}\right) \approx (137)\frac{3.325\times10^{-10}}{1.0153\times10^{-34}} \approx 4.487\times10^{26} \tag{130}$$

where λ_B is the wavelength associated with the first Bohr orbit and λ_P is the Planck wavelength, where the association is mechanical.

In terms of frequencies, since $\lambda_B = \mathrm{V}_B/\nu_B$ and $\lambda_P = c/\nu_P$, we obtain

$$\frac{1}{\alpha}\left(\frac{\lambda_B}{\lambda_P}\right) = \frac{1}{\alpha}\left(\frac{\frac{\mathrm{V}_B}{\nu_B}}{\frac{c}{\nu_P}}\right) = \frac{1}{\alpha}\left(\frac{\mathrm{V}_B}{\nu_B}\right)\left(\frac{\nu_P}{c}\right) = \frac{1}{\alpha}\left(\frac{\mathrm{V}_B}{c}\right)\left(\frac{\nu_P}{\mathrm{V}_B}\right) = \frac{1}{\alpha}\alpha\left(\frac{\nu_P}{\mathrm{v}_B}\right) = \frac{\nu_P}{\mathrm{v}_B} \tag{131}$$

and numerically

$$\left(\frac{\nu_P}{\nu_B}\right) = \frac{2.954\times10^{42}}{6.58\times10^{15}} \approx 4.489\times10^{26} \tag{132}$$

On the other hand, the ratio (132) can be obtained directly by considering the energy ratio between the Planck energy and the Bohr energy

$$\frac{\frac{1}{2}E_P}{\frac{1}{2}E_B} = \frac{\frac{1}{2}h\nu_P}{\frac{1}{2}h\nu_B} = \frac{\nu_P}{\nu_B} \tag{133}$$

In this expression, no coupling with the Planck frequency ν_P is evident, but from our point of view, there should be a coupling between the frequencies.

We note that, for the electron in the first stationary orbit (ground state), the fine structure constant also has the following property

$$\frac{\nu_B}{\nu_C} \approx \frac{6.58\times10^{15}}{1.2355\times10^{20}} \approx 5.348\times10^{-5} = \alpha^2 \tag{134}$$

where ν_C is the Compton frequency of the electron [31]. From this relation, we obtain

$$\nu_B = \alpha^2\nu_C \tag{135}$$

which is replaced in the expression (133), becomes

$$\frac{h\nu_P}{h\nu_B} = \frac{\nu_P}{\nu_B} = \left(\frac{1}{\alpha^2}\right)\frac{\nu_P}{\nu_C} \tag{136}$$

and numerically

$$\left(\frac{1}{\alpha^2}\right)\frac{\nu_P}{\nu_C} \approx \left(\frac{1}{5.348\times10^{-5}}\right)\frac{2.954\times10^{42}}{1.235\times10^{20}} \approx 4.48\times10^{26} \tag{137}$$

Thus, the resonance coupling, which is not explicit in expression (133), must be expressed as

$$\frac{\frac{1}{2}E_P}{\frac{1}{2}E_B}=\left(\frac{1}{\alpha^2}\right)\frac{\nu_P}{\nu_C} \tag{138}$$

thus finding the coupling also for the frequencies.

There are two interesting explanations for why we need the Compton frequency, and both provide very important clues to the Symmetric Theory.

The first explanation is provided by Bohr himself [29], who makes a clear distinction between the mechanical frequency of revolution ν_B of the electron and the frequency of the radiation emitted during the capture phase. This treatment of the atom associates the phenomenon of radiation with the possibility of transitions between pairs of energy states and not with the acceleration of the electron in orbit. Consequently, the frequency of the radiation is not identifiable with the frequency of the orbital electron moving around the nucleus. This concept represented an essential innovation with respect to the previous quantizations of the electron energy (Nicholson), where an energy of the form $\tau\frac{1}{2}h\nu$ was assumed. Bohr specifies that the approximation between the emission frequency and the mechanical rotation frequency is obtained for large values of τ, for transitions between two contiguous stationary states. In this idea, we recognize the line of thought that will lead him to the principle of correspondence between classical mechanics and quantum mechanics in the continuum limit. However, Bohr does not specify what the frequency of radiation is.

In a modern key, the second explanation comes from the concept of de Broglie wave [32], used in quantum formalism to assign wave properties to particles, or as Schrodinger better specifies, to eliminate the particle and represent it through a wave.

According to de Broglie, by contaminating relativity with the Planck-Einstein formula, $E=h\nu=mc^2$, each particle must be associated with an internal wave, the internal "clock". This also causes the particle to be associated with an oscillation in space, which derives from the relativistic 4-vector wave vector $k^\mu=\left(\omega/c,\boldsymbol{k}\right)$. In de Broglie's matter wave theory, an oscillation of Compton frequency

$$\nu_C=\frac{m_o c^2}{h} \tag{139}$$

is associated with a stationary particle (with m_o its rest mass). If the particle moves relative to the laboratory with velocity v along a certain direction, the frequency ν in this reference frame undergoes a Doppler shift according to the formula

$$\nu=\gamma\nu_C\left(1+\beta\right)=\gamma\nu_C+\gamma\beta\nu_C \tag{140}$$

with

$$\gamma=\left(1-\beta^2\right)^{-1/2},\quad \beta=\frac{\mathrm{v}}{c} \tag{141}$$

By setting $m=\gamma m_o$, the shift $\gamma\nu_C\beta$ in (140) can be rewritten as

$$\gamma \nu_C \beta \equiv \gamma \beta \frac{m_o c^2}{h} = \frac{\beta m c^2}{h} = \frac{\mathrm{v}}{c} \frac{m c^2}{h} = \frac{m \mathrm{v} c}{h} = c \frac{m \mathrm{v}}{h} = \frac{c}{\lambda_{dB}} = \nu_{dB} \quad (142)$$

with

$$\lambda_{dB} = \frac{h}{m \mathrm{v}} = \frac{h}{p} \quad (143)$$

the expression of the de Broglie wavelength, which originates in the Doppler shift of the Compton frequency ν_C, and which is directly related to the moving particle. We want to recall that the frequency oscillations ν_C, associated with the particle in its stationary system constitute a clock in de Broglie's theory, and that the Compton wavelength is

$$\lambda_C = \frac{2\pi c}{\omega_C} = \frac{h}{m_o c} \quad (144)$$

Then, the formula (142) is transformed as follows

$$\gamma \nu_C \beta = \nu_B \quad \rightarrow \quad \gamma \frac{c}{\lambda_C} \beta = \frac{c}{\lambda_{dB}} \quad \rightarrow \quad \lambda_{dB} = \frac{\lambda_C}{\gamma \beta} \quad (145)$$

On the other hand, we have

$$\gamma \beta = \frac{\beta}{\sqrt{1-\beta^2}} = \sqrt{\frac{\beta^2}{1-\beta^2}} \quad (146)$$

from which it is obtained

$$\frac{1}{\gamma \beta} = \sqrt{\frac{1-\beta^2}{\beta^2}} = \sqrt{\frac{1}{\beta^2} - 1} = \sqrt{\frac{c^2}{\mathrm{v}^2} - 1} \quad (147)$$

Therefore, (145) takes the form

$$\lambda_{dB} = \frac{\lambda_C}{\gamma \beta} = \lambda_C \sqrt{\frac{c^2}{\mathrm{v}^2} - 1} \quad (148)$$

implying that for non-relativistic motion λ_{dB} it is greater than the Compton wavelength λ_C.

From a physical point of view, the charged electron immersed in the medium Planck has an effective measurement of the order of the Compton wavelength λ_C. As a result, the particle decouples from components of the radiation field with wavelengths shorter than λ_C (and frequencies greater than ω_C) so that the Compton frequency takes on the meaning of *cutoff frequency*. Since the Compton frequency is determined by the size of the particle, this feature is general in nature. In the context, we are dealing with, which is certainly classical, when the particle is in permanent interaction with the medium Planck, after momentary disturbances, the medium Planck puts the particle in resonance with the modes of frequency ω_C, and the particle interacts selectively with a narrow band of modes of the field with frequencies centered around ω_C. Thus, both particle and wave entities appear as an inseparable pair, but with a well-defined complementary nature, where the particle always remains a corpuscle.

Returning to Bohr's article [29], according to him, the dynamic equilibrium of systems that are in stationary states can be discussed according to classical mechanics, while the transition between two different stationary states cannot be treated according to classical mechanics but we add, according to quantum mechanics.

This is a concept with a strong specific weight and great impact. Although it introduces changes to classical mechanics, Bohr does not demonstrate the self-evidence of this concept, which serves as a limitation to having consistency with experimental data from atomic frequency spectra. Perhaps he was hoping for a refinement of the theory, or perhaps he was aware that the development of transition theories poses problems of coexistence between old and new. From our point of view, this intuition was correct, and it is a pity that it has not been developed further.

In practice, when the electron is in stationary configurations, in resonance with the medium Planck, it can be treated classically since it inherits this behavior from the medium Planck, since it has been hypothesized as an ideal gas. While the transitions between energy levels require the statistics of quantum mechanics, since they are stochastic processes. While transitions between energy levels require the statistics of quantum mechanics, since they are stochastic processes.

This would explain the wave-particle duality. Quoting J.G. Cramer [33]: "*In quantum mechanics, as better specified by Bohr's complementarity principle, the wave-particle double logic is considered an intrinsic property of nature. It indicates how to treat without contradictions two sets of notions that, although mutually exclusive, are both necessary. Complementary are not qualities that together, in a single context, contribute to fully defining an entity; but rather, qualities that contribute to this purpose separately, in distinct and mutually exclusive contexts. The entities described by quantum mechanics are waves or particles, never waves and particles together*".

Continuing our research on couplings, we further investigate the dependence on the fine structure constant α, by analyzing the ratio between the Coulomb force for the electron and the Planck force,

$$\frac{F_e}{F_P} = \frac{\dfrac{e^2}{4\pi\varepsilon_o r_B^2}}{\dfrac{q_P^2}{4\pi\varepsilon_o \ell_P^2}} = \frac{e^2}{r_B^2}\frac{\ell_P^2}{q_P^2} = \left(\frac{e^2}{q_P^2}\right)\left(\frac{\ell_P^2}{r_B^2}\right) = \alpha\left(\frac{\ell_P^2}{r_B^2}\right) \tag{149}$$

Numerically we have:

$$F_e = \frac{e^2}{4\pi\varepsilon_o r_B^2} = \frac{\left(1.6021\times10^{-19}\right)^2}{4\pi\left(8.854\times10^{-12}\right)\left(5.292\times10^{-11}\right)^2} \approx 8.237\times10^{-8} \tag{150}$$

$$F_P = \frac{q_P^2}{4\pi\varepsilon_o \ell_P^2} = \frac{\left(1.87\times10^{-18}\right)^2}{4\pi\left(8.854\times10^{-12}\right)\left(1.6160\times10^{-35}\right)^2} \approx 1.20\times10^{44} \tag{151}$$

$$\frac{F_e}{F_P} = \frac{8.237 \times 10^{-8}}{1.20 \times 10^{44}} \approx 6.86 \times 10^{-52} \tag{152}$$

$$\alpha \left(\frac{\ell_P^2}{r_B^2} \right) = \frac{1}{137} \frac{\left(1.6160 \times 10^{-35}\right)^2}{\left(5.292 \times 10^{-11}\right)^2} \approx 6.80 \times 10^{-52} \tag{153}$$

Even in this case, there is a clear dependence between the granularity of the distances.

The unexpected aspect of the couplings we found is the new meaning that the fine structure constant α takes on. Its original definition $\alpha = \mathrm{v}/c$, which expresses the coupling between velocities, is in fact, essentially a coupling condition between the electron and the medium Planck.

As a consequence, as expected from our point of view, the fine structure constant takes on a new meaning also with respect to relation (16). This relationship dictates that the electron, as we know it, can manifest itself when its electric charge is coupled to the Planck charge by the relation

$$e = q_P \sqrt{\alpha} \tag{154}$$

giving rise to the electron and giving it all the characteristics we know.

It is important to underline, however, that the relation (154) does not imply a variability of the electronic charge e as α, nor that α can vary with time. This essentially derives from the property that the electric charge is a relativistic invariant, that is, its value does not depend on the state of motion of the charge carrier. If this were not the case, the exact neutrality of atoms would not be possible. We deduce that the fine structure constant α is the coupling constant with the medium Planck that determines the electron and, therefore, the physical world as we know it. A different value of α would determine a *new electron* and a physical world completely different from the one that emerges from current investigations. Obviously, nothing prevents other fundamental particles from having coupling factors different from the value of α.

From what has emerged so far, we can highlight that:

$$m_e \mathrm{V}_B^2 = \left(9.109 \times 10^{-31}\right)\left(2.18 \times 10^{6}\right)^2 \approx 4.36 \times 10^{-18}\ \mathrm{J} \tag{155}$$

$$h\nu_B = \left(6.626 \times 10^{-34}\right)\left(6.58 \times 10^{15}\right) \approx 4.36 \times 10^{-18}\ \mathrm{J} \tag{156}$$

from which the energy equivalence for the electron in the ground state is obtained:

$$m_e \mathrm{V}_B^2 = h\nu_B \tag{157}$$

which we recall is a mechanical equivalence, since ν_B expresses a mechanical rotation frequency. Or, in terms of radiation, we can write:

$$m_e \mathrm{V}_B^2 = \alpha^2 h\nu_C \tag{158}$$

This suggests that, if we take into account the correct quantities to be considered, a relationship similar to the energetic reunification at the Planck scale could be valid, as already expressed by (31),

$$k_B T_P = m_p c^2 = h\nu_P \tag{159}$$

Speculating further on the relation (157), we can go further as follows

$$m_e V_B^2 = h\nu_B = k_B T_o \tag{160}$$

These concepts, although in a different form, are not entirely new in physics, however, they have gone unnoticed. Historically, in 1916, Nernst proposed to consider atomic stability as the experimental evidence of Planck's discovery of zero-point radiation, but this visionary idea was ignored. Nernst's central idea was based on the conception, coming from his discovery of the third law of thermodynamics, that at very low temperatures, energy has a dynamically ordered character, and therefore interpreting Planck's zero-point energy as an ordered energy. This is a revaluation of the idea already advanced by Boltzmann that only a part of the mechanical energy contributes to the thermodynamic internal energy, namely only the concretely exchangeable one, which dynamically has a disordered character. According to Nernst, there was a characteristic temperature T_c (which he called the degeneracy temperature), below which all the internal energy is available to perform macroscopic work. Therefore, thermodynamic energy does not coincide with the mechanical energy of the system considered, but only with that fraction of energy that is disordered and can actually be exchanged in a thermal process. From the energetic point of view, for a system of oscillators, for Nernst, the energy $h\nu$ constitutes the *critical threshold*, below which there are predominantly ordered motions, while above which there are predominantly disordered motions. Applying the Maxwell-Boltzmann statistics (and therefore the equipartition), the exchangeable energy is conceived as the energy that is obtained by $k_B T$ subtracting the ordered energy, and this latter energy, for Nernst, is the Planck energy, according to the formula

$$E = k_B T - \frac{h\nu}{e^{\frac{h\nu}{k_B T}} - 1} \tag{161}$$

A noteworthy conclusion, from our point of view, was reached by Wheeler [34] in 1955, where he stated that "*space-time must have fluctuations at the maximum frequency of the Planck frequency*". This idea was further addressed in the last chapter of the biblical book *Gravitation* [35].

From what has emerged so far, the fact that in the stationary states following the ground state, the electron does not radiate indicates that in these energy levels, the electron establishes resonance configurations with the medium Planck.

As a speculative theory, the *Symmetric Theory* might seem at first sight a topic more relevant to the universe in the primordial phases, immediately after the big bang, in the Planck era. However, the characteristics that identify the Planck particle, as has been shown throughout this article, are present throughout the scientific literature and applied in today's physics, even if in a different guise. Thus, the fundamental equations (31) and (160), which show the wave-particle duality, remain valid for the universe and for physics in the current state. Their application is not restricted to the initial epoch of the universe. These are relations that continue to be applied even today. Therefore, wanting to provide a reason for experimental verification, we conclude with a final speculation on the energetic unification of the electron in the ground state. From relation (160), we can derive the temperature at which the electron would be found in the ground state of the hydrogen atom:

$$T_o = \frac{m_e V_B^2 = h\nu_B}{k_B} \approx \frac{4.36\times10^{-18}}{1.380\times10^{-23}} \approx 3.160\times10^5\ \text{K} \tag{162}$$

6. Discussion

When, in the study of a phenomenon, a certain coincidence occurs incidentally, our logic pushes us to investigate why that peculiarity occurred and what special conditions came into play. But if the coincidence repeats itself systematically, every time it is expected, then it can no longer be treated as casual. The coincidence becomes a structural fact of the phenomenon. From the beginning, the importance of the medium Planck has been clear to us, and the *Symmetric Theory* is undoubtedly a speculation in search of relations between the medium Planck and the world as we perceive it.

From our point of view, understanding the laws of nature must necessarily take into account the concept and physical content of the vacuum as an integral part of the structure of the universe, understood as the *factory of space*. In this context, the vacuum, or the Planck medium, or whatever name we want to give it, offers more logical physical explanations to phenomena of which we have a formalism but not a total understanding. Everything is based on zero-point field radiation, with non-zero energy at zero temperature, foreign to classical physics, but treatable classically.

Considering the zero-point field as a fundamental constituent offers the possibility of explaining in a unitary way phenomena that have an explanation but that do not fit into an overall scenario, as we have instead highlighted, showing the close connection of some phenomena with the medium Planck.

The fact that the electron is supported by the medium Planck, reveals the mystery of atomic stability. The permanent action of the medium Planck on the classical particle represents a *qualitative* paradigm shift from the dynamical point of view. Particles behave classically when they are stably in resonance with the medium Planck and acquire quantum properties when they perform transitions between energy states. The effect of the field—medium Planck—is no longer *perturbative*. Obviously, this new situation requires a new description.

7. Conclusions

Symmetric Theory arises from the effort to find answers to the conceptual puzzles of modern physics, providing, on logical foundations, an alternative way. It is not a further interpretation of quantum mechanics or a form of cosmology, but it constitutes a comprehensive and self-consistent theoretical system, based on principles in line with the realistic view of nature. We have not included philosophical considerations to assign a physical meaning to the elements of the theory, and to interpret its results. The medium Planck is a privileged reference frame whose oscillations generate everything in the universe: all particles, all forces, and all fields. Everything is determined by resonances at frequencies lower than the *medium* Planck.

Symmetric Theory is a non-traditional theoretical proposal. At first sight, it may seem to depart from the standard canons of physics, but this is only the effect of a new vision of the world. All we need, perhaps, is already written in the scientific literature. The only weapon required is a dose of imagination for a new interpretation of the phenomena we already know. If *Symmetric Theory* were correct, the phenomena that seem separate in different theories would be different aspects of a single symmetry.

Zero-point energy is not a simple quantum curiosity, but an integral part of the structure of the universe, capable of influencing the geometry of space-time and, therefore, its dynamics.

From our point of view, as introduced at the beginning, despite the unpredictable chaos, our experience shows us a world with coherence and continuity. We have identified mysterious numbers, the constants of nature, which give the universe its distinctive structure as we know it today. These constants of nature represent, at the same time, our maximum knowledge and our extreme ignorance of the universe. Their existence is, perhaps, the greatest mystery of science, and they contain the code of the deepest secrets of the universe.

Conflicts of Interest

The author declares no conflicts of interest.

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