Similarities Between the Dirac-Inspired Planck Vacuum Theory and the Urantia-Book Papers' Concept of the Vacuum State

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The Planck vacuum (PV) theory [1][2] [Appendix] defines the vacuum state as a degenerate, negative-energy collection of Planck particles that interacts with free-space particles to generate the various equations of modern fundamental physics. And although the theory is not yet in the theoretical mainstream, the present author believes it to be the model that best represents the current approximation to the physical scheme of things. The success of the theory is due in part to its replacing three important secondary constants (G, $\hbar$, α) with two more-fundamental constants (e_*, m_*) in the various equations. In contrast to the PV model, the Urantia-Book (UB) Papers [3] define a set of two fundamental energy states which will be referred to here as the UB vacuum (UBV). Similarities between these two descriptions of the vacuum state, the PV and the UBV, will be explored below.

1 Urantia-Book Vacuum

There are one hundred ninety-six Papers that constitute the UB—its publication being one of those historical events that brings forth an abundance of criticism both positive and negative. Having studied the Papers for over forty years, the present author's opinion is decidedly positive. Nevertheless, the reader is not asked to accept the author's bias, only to consider the fundamental physics of the topics examined. The reader unfamiliar with the book can become acquainted therewith by visiting the website www.urantia.org. The twenty-one-hundred-page UB can also be downloaded at no cost from this website. The book was first published in English in 1955 and has since been published in fourteen other languages.

A number of the Papers discuss ideas that can be associated with the vacuum state as it is viewed from the perspective of the PV theory. However, the validity of these ideas is limited somewhat by the known physics significantly predating circa 1955 when the book was first published and may thus be in need of revision [4]. The material of interest is referenced in the UB according to the format 'Paper-number:section-number.paragraph-number'. For example, the reference [42:6.1] refers to Paper 42, Section 6, paragraph 1—the first paragraph in Section 6 of Paper 42 entitled "Ultimatons, Electrons, and Atoms".

First, it is important to note what the words force, energy, and power mean in the UB lexicon [5]. The word energy is used to denote all phases and forms of phenomenal motion, action, and potential, while force is applied to the *pre-gravity*, and power to the *post-gravity* stages of energy.

Of interest here are the two omnipresent energy states [6] alluded to in the abstract: primordial force and gravity energy. Space potency is a pre-reality from which the primordial-force state is derived, the latter representing the first basic change in space potency (a change from passive and potential force to active and primordial space energy). The primordial-force state undergoes two distinct changes, progressing through the puissant-energy phase to the gravity-energy state. This final state carries the potential of universe power (physical energy) and becomes the active ancestor of all universe matter. Under stress, energy is ejected from the gravity state into free space in the form of ultimatons, the first measurable form of energy [7]. The term 'universe power' refers to material appearing in the visible universe, more particularly in the present context to electrons, protons, and ultimatons.

Mutual attraction holds one hundred ultimatons together in the constitution of the electron and there are never more nor less than one hundred ultimatons in a typical electron [8]. The axial velocity (spin) of the ultimatons slows down through many phases of physical activities before reaching the revolutionary energy prerequisite to electronic organization. This same axial velocity determines the negative or positive reactions of the several types of electronic units. The ultimatons do not describe orbits within the electrons; they spread or cluster in accordance with their axial velocities, thus determining the differential electronic dimensions. The entire segregation and grouping of electronic matter, together with the electric differentiation of negative and positive bodies of energy-matter, result from these various functions of the component ultimatonic inter-association.

The gravitational attraction between masses in free space is referred to as linear or local gravity [9]. *This form of gravity pertains to the electrical stage of energy or matter.* However, *ultimatons do not respond to local gravity* [10]. Their is also an omnipresent form of gravity termed 'absolute gravity' about which this paper does not concern itself.

The so-called aether is nothing more than a collective name to designate a group of force and energy activities occurring in space [11]. Ultimatons, electrons, and other mass aggregations of energy are uniform particles of matter, and in their transit through space they proceed in direct lines. Light and all other forms of recognizable energy manifestations consist of a succession of definite energy particles which proceed in direct lines except as modified by gravity and other intervening forces. That these processions of energy particles appear as wave phenomena when subjected to certain observations *is due to the resistance of the undifferentiated force blanket* of all space, the hypothetical aether, and *to the intergravity tension of the associated aggregations of matter.* The spacing of the particle-intervals of matter, together with the *initial velocity* of the energy beams, establishes the undulatory appearance of many forms of energy-matter. Space is not empty; the spheres of all space whirl and plunge through a vast ocean of outspread force-energy; neither is the space content of an atom empty. Nevertheless there is no aether, and the very absence of this hypothetical aether enables a planet to escape falling into its sun or an encircling electron to escape falling into the nucleus.

The term 'undifferentiated force blanket' (the primordial-force blanket) in the context of the previous paragraph implies that the blanket is a permanent fixture of the UB cosmology since it must interact with free-space particles to produce the wave-like nature of those particles. Thus the primordial-force state must coexist with the gravity-energy state. [The previous commentary extracted from the UB concerning the mutation of energy states is confusing in that it seems to imply that the primordial-force state is just a temporary step (like the puissant-energy phase) to the final gravity-energy state.] For convenience this composite state, the primordial-force state plus the gravity-energy state, is referred to in the present paper as the UBV although the UB does not use this designation. Furthermore, the UBV so defined is meant only as a discursive vehicle for comparing the PV and UB ideas.

There is *innate in matter* and *present in universal space* a *form of energy* not known on Urantia [12]; and the gravity-energy state discloses a certain potential for sensitivity to the *linear-gravity pull* inherent in the soon appearing material mass of the electronic and the post-electronic stages of energy and matter [13].

2 PV-UBV Similarities

The following comparison between the PV state and the UBV state assumes that the reader is familiar with the updated summary of the PV theory presented in the Appendix.

Founded on the idea of a Dirac "sea", the PV is an omnipresent negative-energy vacuum state that interacts with free-space particles. For example, the uniform motion of a massless point charge e_* perturbs the PV with the electric force e_*^2/r^2 that invokes a PV response consisting of Faraday and magnetic fields, leading to the relativistic electric and magnetic fields of a uniformly moving charge and the Lorentz transformation. In addition, the uniform motion of a massive point charge perturbing the PV leads to the Dirac equation. The experimental confirmation of both the Lorentz transformation and the Dirac equation thus provide strong evidence for the existence of the PV as an omnipresent physical reality. The General theory of relativity provides additional confirmation.

The PV is capable of injecting energy directly into free space: e.g., where the PV is stressed by the potential e_*^2/r of a massive point charge, the negative energy levels of the PV overlap the positive energy levels of free space in the spherical region within $r < r_e/2$, where r_e is the electron Compton radius—the result being the appearance of electrons in free space and positron holes in the PV. Extrapolating this injection process to the proton, it is reasonable to conclude that the PV is the source of the electron-proton particle energy from which the visible universe is constructed, the heavier particles being formed in subsequent free-space processes.

The similarity between this process and the dumping of energy in the form of ultimatons into the visible universe described in the last section is evident—the PV and the UBV are both reservoirs of energy from which the visible universe

comes into being. The resemblance between the PV and the UBV is further enhanced if it is assumed that the gravity-energy part of the UBV consists of a degenerate collection of negative-energy ultimatons. Even without this latter supposition, however, the two processes of universe building are roughly the same.

The difference between the massless point charge e_* and the Dirac electron (the massive point charge) consists in the fact that the electron has an acquired mass (A7) due to its charge e_* being driven by the zero-point virtual fields permeating free space. This form of mass is clearly recognized in the previous section by the statement *this form of gravity pertains to the electrical stage of energy or matter.*

The ultimaton *does not respond the local gravity* however; so it seems reasonable to conclude that the ultimaton is massless. The two hints the UB gives concerning the ultimaton's makeup is that it is a uniform particle of energy having a variable rate of spin and that, together with ninety-nine other ultimatons, coalesces to form the electron. If one speculates that the ultimaton carries a massless charge $(e_*/100)$ similar to the charge(e_*) of the Planck particles in the PV, then in free space (A7) leads a local-gravity pull (mc^2/r) that is 100^2 times less than that of the electron as the mass (A7) is proportional to the squared charge. So, compared to the electron, perhaps it is an approximation for the UB to state that the ultimaton does not respond to local gravity. Whatever the case, the ultimaton is mostly an unexplored question mark at this point in time.

Concerning gravity and mass, the UB makes the comment that gravity acts in the plane perpendicular to the mass [14]. Taking this comment somewhat out of context by applying it to local gravity, it appears to refer to the two-thirds ratio in (A7) whose origin is due to the fact that the dipole electric fields exchanged between two gravitating particles are limited to the planes through the particles that are perpendicular to the radius connecting those particles [15].

The two statements in the previous section that the wave nature of the particle *is due to the resistance of the undifferentiated force blanket ... to the intergravity tension of the associated aggregations of matter*, and that the wavelength of these particles of matter is related to their *initial velocity* (v); find a close parallel in the PV model of an electron in uniform motion. For an electron stressing the PV the intergravity tension is the curvature force

$$\frac{m_e c^2}{r} = \frac{m_e c^2}{r}\frac{G}{G} = \frac{m_e c^2}{r}\frac{G}{e_*^2/m_*^2} = \frac{m_e c^2}{r}\frac{m_*^2 G}{r_* m_* c^2} = \frac{m_e m_* G}{r_* r} \qquad (1)$$

where it is evident from the final ratio that the electron (m_e) is perturbing the PV (m_*/r_*) with a gravitational-type force (G). The intergravity tension in this case corresponds to the interaction between the electron mass m_e and the masses (m_*) of the Planck particles constituting the PV.

The total force the Dirac electron of the previous paragraph exerts on the PV is

$$\frac{e_*^2}{r^2} - \frac{m_e c^2}{r} \qquad (2)$$

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where the first force in the difference is the polarization force the electron charge $(-e_*)$ exerts on the Planck particles $(-e_*)$ within the PV, the total force vanishing at the electron's Compton radius $r_e \; (= e_*^2/m_e c^2)$. The vanishing of this force difference is a Lorentz-invariant constant (0) in the PV theory; so Lorentz transforming this vanishing force ((2) with $r = r_e$) should lead to another constant of the theory. This additional constant turns out to be the electron's de Broglie radius

$$r_{ed} = \frac{r_e}{\beta\gamma} = \frac{e_*^2/m_e c^2}{\beta\gamma} = \frac{e_*^2/c}{m_e\gamma c\beta} = \frac{\hbar}{p_e} \qquad (3)$$

where $p_e \; (= m_e\gamma v)$ is the relativistic electron momentum and $\lambda_{ed} = r_{ed}/2\pi$ is the de Broglie wavelength. It is clear that this wavelength is related to the *initial velocity* (v) of the electron, confirming the second statement of the previous paragraph.

The final paragraph of the preceding section claims that the UBV discloses a certain potential for sensitivity to the *linear-gravity pull* inherent in the material mass of a particle. The previous two paragraphs demonstrate this statement for the linear-gravity pull $(m_e c^2/r)$ of the electron. The final paragraph also claims that there is *innate in matter* and *present in universal space* a *form of energy* unknown to physicists significantly before the time the UB was published. The *present in universal space* and *innate in matter* phrases strongly suggest that: this energy is the universal zero-point energy associated with the Planck particles making up the PV; and the resulting zero-point virtual fields of free space that drive the charge of the free electron, leading to the electron mass (A7).

3   Summary and Comments

The preceding two sections suggest a strong similarity between the Dirac-inspired PV and the UBV states in that they both: act as energy reservoirs for the visible universe; are permeated with zero-point energy; inject energy in the form of some basic type of massless particles into free space; interact with massive free particles to produce the wavelike nature associated with those particles; and are subject to the local-gravity pull (mc^2/r) of the massive free particles.

From the UB statements the superficial nature of the UBV is the easy to visualize. There exists an omnipresent, undifferentiated, UBV force-energy-blanket with a sensitivity to the local-gravity pull of the free-space particles. Stresses to this fundamental blanket [16] eject ultimatons into free space in the neighborhood of those stresses. Some or all of the injected ultimatons eventually "condense" into electrons or protons.

The nature of the PV has been only loosely defined in terms of a vague reference to a Dirac "sea" and the string of Compton relations in (A9)—the reason for this vagueness being a lack of experimental evidence to take the calculations much further. Perhaps the large-collider experiments [17] will remedy this shortcoming. The presence of a PV-like state is, however, fairly well established by: the Pemper derivation [18] [19] of the relativistic electric and magnetic fields

of a uniformly moving charge, and the corresponding Lorentz transformation; the Beckmann derivation [20] [21] of the de Broglie relation for a uniformly moving Dirac electron and its agreement with the results of the corresponding PV derivation; and the line of reasoning leading from the PV perturbation (A4) to the Dirac equation (A6) and the supporting experimental evidence. Under a sufficient stress, the PV is assumed to inject electrons and anti-protons (both negatively charged particles) into free space, and positrons and protons (both in the form of PV holes) into the PV.

The PV theory defines free space (see FS in the Appendix) as a composite entity consisting of the classical void permeated by the zero-point electromagnetic vacuum, the PV itself being separated from this free-space model. Also, electromagnetic fields existing in FS are assumed to permeate the PV, and vice versa; so FS and the PV must be closely related geometrically. One way to accomplish this closeness is to "lay two three-dimensional spaces on top of each other", creating a six-dimensional space consisting of two "parallel" three-dimensional subspaces. In this context it is interesting to note that the UB claims that space is ultimately of a seven-dimensional nature [22]—the seventh dimension representing perhaps the spacetime mixing of space and time caused by the composite force in (2).

The present paper closes with the following thought-provoking statement [23]: "The [spacetime] concept of a mind of material origin is destined to undergo successive enlargements as the conscious and conceiving personality ascends the levels of the universes. When man attains the mind intervening between the material and the spiritual planes of existence, his ideas of [spacetime] will be enormously expanded both as to quality of perception and quantity of experience. The enlarging cosmic conceptions of an advancing spirit personality are due to augmentations of both depth of insight and scope of consciousness. And as personality passes on, upward and inward, to the transcendental levels of Deity-likeness, the [spacetime] concept will increasingly approximate the timeless and spaceless concepts of the Absolutes."

Dedication

This paper is dedicated to the memory of Sandy and Timmy who passed away on Urantia way before their time should have been up.

Appendix: PV-Model Update

Previous to the PV theory [1] the equations of modern fundamental physics were forced to rely on the constants G (Newton's gravitational constant), $\hbar$ (Planck's constant), and α (the fine structure constant). With the advent of the new theory, however, these *secondary* constants are replaced by the *primary*

constants e_* and m_* on the right side of the equations

$$G = \frac{e_*^2}{m_*^2} \qquad \hbar = \frac{e_*^2}{c} \qquad \text{and} \qquad \alpha = \frac{e^2}{e_*^2} \tag{A1}$$

where e_* and m_* are the bare charge and the Planck mass [24] respectively, c is the speed of light, and e is the observed electronic charge. As a consequence of this replacement the Dirac equation [25][26][27] implies the existence of a negative-energy vacuum state as a fundamental physical entity with which free-space particles interact.

The PV theory defines free space (FS) as a composite entity consisting of the classical void permeated by the zero-point electromagnetic vacuum, a collection of virtual fields with the PV as their source [28]. The PV itself is a degenerate collection of negative-energy Planck particles with a negative Planck mass $(-m_*)$ and a negative bare charge $(-e_*)$ [27]. Electromagnetic fields generated by particles in FS, or the Planck particles within the PV, are assumed to freely permeate *both* FS and the PV. The zero-point virtual fields generated by the zero-point agitation of the Planck particles in the PV are an example of the latter.

The permittivities μ and ϵ of FS+PV are given by [1]

$$\mu = \frac{1}{\epsilon} = \frac{r_* m_* c^2}{e_*^2} = 1 \tag{A2}$$

which in MKS units become

$$\mu_0 = \frac{1}{\epsilon_0 c^2} = 4\pi \frac{r_* m_*}{e_*^2} \qquad \text{[mks]} \tag{A3}$$

where r_* is the Planck-particle Compton radius (Planck length [24]). (The magnitude of μ_0 is easy to remember—it is $4\pi \times 10^{-7}$ in MKS units. Thus the ratio $r_* m_*/e_*^2$ in (A3) had better equal 10^{-7} and it does.) This simple permittivity view can be upset, however, in regions where the PV is overly stressed.

A massive point charge (the Dirac electron) in FS stresses the PV with the two-fold force [26]

$$\frac{e_*^2}{r^2} - \frac{m_e c^2}{r} = \frac{e_*^2}{r^2} - \frac{e_*^2/r_e}{r} = \frac{e_*^2}{r^2}\left(1 - \frac{r}{r_e}\right) \tag{A4}$$

where the force vanishes at the electron's Compton radius r_e $(= e_*^2/m_e c^2)$, and where one of the charges $(-e_*)$ in the product e_*^2 belongs to the electron and one $(-e_*)$ belongs to the individual Planck particles constituting the PV. For $r > r_e$ the force compresses the vacuum and for $r < r_e$ the opposite occurs. Ignoring the second term in (A4), the electron potential (e_*^2/r) stressing the PV and the inequality $e_*^2/r > E + m_e c^2$ lead to

$$r < \frac{e_*^2}{E + m_e c^2} = \frac{r_e}{1 + E/m_e c^2} < \frac{r_e}{2} \tag{A5}$$

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where $E^2 = m_e^2 c^4 + c^2 p^2$ and p is the relativistic momentum. The negative energy levels within the radius $r_e/2$ now *overlap* the positive energies of FS, resulting in electron-positron pairs being created (the electron traveling in FS and the positron in the PV). Thus a cloud of virtual electron-positron pairs appears, getting more dense as the point electron is approached, and the simple permittivity view in (A2) is destroyed.

The Lorentz-covariant Dirac equation can be expressed as [19]

$$\left(i e_*^2 \gamma^\mu \frac{\partial}{\partial x_\mu} - m_e c^2 \right) \psi = 0 \qquad (A6)$$

where $\mu = 0, 1, 2, 3$. The e_*^2 and $m_e c^2$ in (A6) are the result of the composite stress in (A4). The electron mass m_e results from the free electron charge $(-e_*)$ being driven by the FS zero-point electromagnetic fields. A nonrelativistic expression for this mass is [28] [15]

$$m_e = \frac{2}{3} \frac{\langle \dot{r}^2 \rangle^{1/2}}{c} m_* = \frac{2}{3} \frac{\langle \dot{r}^2 \rangle^{1/2}}{c} \frac{e_*^2}{r_* c^2} \qquad (A7)$$

where $\dot{\mathbf{r}}$ represents the random excursions of the zero-point-driven bare charge about its center of (random) motion at $\mathbf{r} = 0$.

Using $G = e_*^2/m_*^2$ from (A1) and $r_* m_* c^2 = e_*^2$ from (A9), the second term on the left side of (A4) can be expressed as

$$\frac{m_e c^2}{r} = \frac{m_e m_* G}{r_* r} \qquad (A8)$$

showing that this second term represents a gravitational attraction between the free electron and the Planck particles of the PV. This is assumed to be the same van-der-Waals type of force that leads to (A7).

Particles and antiparticles are related by the string of Compton relations [27]

$$r_e(\pm m_e c^2) = \cdots = r_p(\pm m_p c^2) = \cdots = r_*(\pm m_* c^2) = \pm e_*^2 = \pm c\hbar \qquad (A9)$$

where the subscripts e and p refer to the electron and proton respectively. The r's are Compton radii given by $r_e = e_*^2/m_e c^2$ for example. The separation of the $r \cdot m$ products on the left from the e_*^2 on the right side of the equations imply that the bare charge e_* is massless, a primary assumption in the PV theory. The positive signs denote FS particles and the negative signs Dirac-type "holes" [25] in the PV, where the holes *appear* to be positive charges acting within FS because their corresponding Coulomb-like fields permeate both the PV and FS. The de Broglie radius [28] corresponding to the Compton radius r_e, e.g., is

$$r_{de} = \frac{r_e}{\beta \gamma} \qquad (A10)$$

where $\beta = v/c$ and $\gamma = 1/\sqrt{1 - \beta^2}$.

As positive charges do not exist in the PV theory, the proton must be some type of PV hole. Thus, because the positively charged proton is a creature of the PV, it exists and travels within the negative-energy PV state. In summary, negatively charged particles are free-space particles while positively charged "particles" are PV holes [27]—for example, the electron and anti-proton are FS particles while the positron and proton are PV holes.

In the PV theory the Einstein and Schwarzschild equations become [1]

$$G_{\mu\nu} = \frac{8\pi T_{\mu\nu}}{m_* c^2 / r_*} \tag{A11}$$

and

$$ds^2 = -\left[1 - 2n(r)\right] c^2 dt^2 + \frac{dr^2}{\left[1 - 2n(r)\right]} + r^2 d\Omega^2 \tag{A12}$$

where the n-ratio is

$$0 \le n(r) \equiv \frac{mc^2/r}{c^4/G} = \frac{mc^2/r}{m_* c^2 / r_*} < 1 \tag{A13}$$

where ds is the Schwarzschild line element, and dt and dr are the time and radius differentials. (The inequality places definite limits on the validity of the Einstein field equations and hence on the General theory.) The line element in (A12) is associated with the curvature of spacetime outside a static spherical mass— in the particle case the equation is only valid outside one-half the particle's Compton radius. For a vanishing mass ($m = 0$), the n-ratio vanishes and the metric bracket $[1 - 2n(r)]$ reduces to unity; in which case (A12) describes a flat (zero curvature or Lorentzian) spacetime.

That the n-ratio in (A12) and (A13) is not just a mathematical artifact of the General theory can be seen in Newton's static gravitational-force equation between two masses m_1 and m_2:

$$\frac{m_1 m_2 G}{r^2} = n_1(r) n_2(r) \frac{m_* c^2}{r_*} \tag{A14}$$

where $(i = 1, 2)$

$$n_i(r) = \frac{m_i c^2 / r}{m_* c^2 / r_*} \tag{A15}$$

are the relative curvature stresses the masses exert on the PV.

The PV theory has progressed to this point without seriously addressing particle spin—its success without spin suggesting perhaps that spin is an acquired property, like the electron mass (A7), rather than an intrinsic property of the particle. A circularly polarized zero-point electric field may, in addition to generating the electron mass, generate an effective spin in the particle. This conclusion follows from a stochastic-electrodynamic spin model [29] [28] that uses a circularly polarized zero-point field in the spin-modeling process.

References

[1] Daywitt W.C. The Planck Vacuum, *Progress in Physics*, v. 1, 20, 2009.

[2] Daywitt W.C. A Paradigm Shift from Quantum Fields to the Planck Vacuum, to be published in *Galilean Electrodynamics*. See also www.planckvacuum.com.

[3] Multiple Authors, The Urantia Book. Second Edition, Urantia Foundation, Chicago, Illinois, U.S.A., 1955. See also www.urantia.org.

[4] Multiple Authors (1955) op. cit., [101:4.2].

[5] Multiple Authors (1955) op. cit., [42:2.1].

[6] Multiple Authors (1955) op. cit., [11:8.5,6,7,8], [15:4.2], [42:2.3,5,7,8,10,11,12,14].

[7] Multiple Authors (1955) op. cit., [42:1.2], [42:3.3].

[8] Multiple Authors (1955) op. cit., [42:6.4,5,6].

[9] Multiple Authors (1955) op. cit., [11:8.3].

[10] Multiple Authors (1955) op. cit., [41:9.2].

[11] Multiple Authors (1955) op. cit., [42:5.14].

[12] Multiple Authors (1955) op. cit., [42:1.3].

[13] Multiple Authors (1955) op. cit., [42:2.12].

[14] Multiple Authors (1955) op. cit., [11:8.9].

[15] Puthoff H.E. Gravity as a Zero-point-fluctuation Force, *Phys. Rev. A*, v. 39, no. 5, 2333-2342, 1989.

[16] Multiple Authors (1955) op. cit., [42:2.14].

[17] The Large Hadron Collider. http://lhc.web.cern.ch/lhc/.

[18] Pemper R.R. A Classical Foundation for Electrodynamics, Master Dissertation, U. of Texas, El Paso, 1977. Barnes T.G. Physics of the Future—A Classical Unification of Physics, Institute for Creation Research, California, 81, 1983.

[19] Daywitt W.C. The Lorentz Transformation as a Planck Vacuum Phenomenon in a Galilean Coordinate System, *Progress in Physics*, v. 1, 3, 2011.

[20] Beckmann P. Einstein Plus Two. The Golem Press, Boulder, Colorado, 1987.

[21] Daywitt W.C. The Compton Radius, the de Broglie Radius, the Planck Constant, and the Bohr Orbits, *Progress in Physics*, v. 2, 32, 2011.

[22] Multiple Authors (1955) op. cit., [130:7.6].

[23] Multiple Authors (1955) op. cit., [130:7.8].

[24] Carroll B.W., Ostlie D.A. An Introduction to Modern Astrophysics. Addison-Wesley, San Francisco—Toronto, 2007. See p. 1234.

[25] Dirac P.A.M. A Theory of Electrons and Protons, *Proc. Roy. Soc. Lond.*, A126, 360, 1930.

[26] Daywitt W.C. The Dirac Electron in the Planck Vacuum Theory, *Progress in Physics*, v. 4, 69, 2010.

[27] Daywitt W.C. Particles and Antiparticles in the Planck Vacuum Theory, *Progress in Physics*, v. 1, 55, 2011.

[28] Daywitt W.C. The Source of the Quantum Vacuum, *Progress in Physics*, v. 1, 27, 2009.

[29] de la Peña L., Cetto A.M. The Quantum Dice—an Introduction to Stochastic Electrodynamics. Kluwer Academic Publishers, Boston, 1996. See p. 261.