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Astronomical Observations Support Dirac's Hypothesis of Matter Creation Caused by Quantum Fluctuations

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ABSTRACT

Recent astronomical observations have questioned the validity of the Big Bang theory. Well-known physicists Arthur Eddington, Fred Hoyle and Paul Dirac strongly opposed the paradigm. Black holes are described as objects that prevent light from escaping due to gravitational force. Little attention has been paid to the possible extraordinary properties of such objects. Here, the universe is considered as a black hole. The Schwarzschild radius stands for the outer event horizon, whereas the real radius is half thereof. The negative potential energy of any object on the interface equals the mass energy of said object. We postulate that inside a black hole, positron-electron pairs evolve as a certain fraction of the Planck energy. On the outside of a black hole in the galaxy center, proton-antiproton pairs are ejected, creating baryonic matter. The creation of matter increases the space. Outside the universe there is no space, instead of space, time is created. The current CBU-model (Continuously Breeding Universe) explains dark energy and dark matter. Moreover, it changes the relationship between the redshift and the scale factor, bringing light sources closer to the present. As a result, the Hubble tension and the age of early galaxies are explained. The CBU model predicts that time and photons are quantized.

Keywords: cosmology, general relativity, black holes, quantum fluctuations, twin paradox.

INTRODUCTION

Theories of the universe have varied over the years, but the leading paradigm has remained, the theory of the Big Bang (BB), first published in 1931 by the Georges Lemaitre, a recognized astronomer and also a Catholic priest [1]. The idea of a universe undergoing continuous expansion was based on Edwin Hubble's earlier observations. Here the Standard model will be used referring to the **Λ**CDM model.

The cosmic microwave background radiation (CMB) is the main reason for the success of the Standard model. The homogeneous distribution of a sudden occurrence of EM radiation from all directions, about 380,000 years after the BB is considered the best evidence of an energy relic left over when the rest of the energy was bound to matter at the "last scattering" moment. However, the Standard model has serious problems. The origin of the energy at the BB instant is an open question. To explain the expansion of the universe, one had to introduce an extra factor into Einstein's general relativity equations, the cosmological constant **Λ**. The constant represents what is known as dark energy. This is an unorthodox way of doing physics: to introduce a label and start working as if there is a theory. The same applies to the concept of dark matter, which seemed necessary to explain the strange rotation patterns of the galaxies.

In an accelerating universe, however, the Coriolis effect offers a plausible solution to the problem [2]. Moreover, there is a physical explanation for the term "dark matter", it has an exact accordance with the kinetic energy due to the expansion.

Recent observations made by the James Webb Space Telescope (JWST) have relieved discrepancies in the estimation of the Hubble parameter, the Hubble tension. New measurements indicate errors in the time scaling causing doubts about the correctness of the Standard model, cf. [3].

In 1937, the renowned physicist Paul Dirac published an article entitled “The cosmological constants”, where he developed the hypothesis of large numbers [4]. In the background there is the coincidence of a large ratio between EM forces and gravitational forces, typically 10^{41} and its squared value 10^{82}, which also stands for the Eddington number, the estimated number of protons in the universe, i.e. the matter energy content. However, the response was sceptical, as the theory offered very little to elaborate on. Dirac published a more detailed paper in 1974 [5], where he presents the general ideas of Multiplicative Creation and Additive Creation. He saw these as different options not both combined. The former refers to an inherent production of matter and the latter implies a continuous influx of new matter.

In this article we will show that a combination of both takes place, the universe grows due to the influx of electron-positron pairs caused by quantum fluctuations. Protons and antiprotons are "swinged out" from the black holes in the centres of the galaxies, a process similar to the influx of electron-positron pairs. Protons, electrons, and their antiparticles are generally considered the only stable elementary particles available. The theory is called CBU, which stands for the Continuously Breeding Universe.

POSTULATES AND THE PRINCIPLE OF A DIRAC UNIVERSE

The origin of the Big Bang is completely shrouded in mystery and therefore it is a precarious start for a physics theory. To build a new paradigm, we must rely on known facts. The universe is expanding and there are signs that the expansion is accelerated, although the acceleration is extremely small. The universe is filled with galaxies consisting of gravitationally heavy centers, black holes, and stars with accompanying planetary systems. In addition, there are interstellar radiation and free elementary particles. The universe is a closed entity that encompasses all of space within itself. The black holes are physical objects following known physical laws.

The Dirac suggestion of 1974 offers a logical solution. We suggest the following:

- **Postulate 1**: The universe is a low-density black hole.
- **Postulate 2**: The gravitational parameter G (Newton’s constant) is inversely proportional to the curvature radius r of the universe.
- **Postulate 3**: Black holes are "bodies of creation", on the inside a fraction of quantum fluctuation particles are converted into real particles, on the outside there are two alternatives: a) for the universe black hole the Ground state energy E_{GS} of the Schrödinger wave function gives rise to a quantum time unit $t_q = h/E_{GS}$, b) the inner galaxy black holes induce proton-antiproton pairs into the space outside itself and positron-electron pairs inside itself.

It is assumed that at the Initial Event (beginning of the universe) a positron-electron pair arises. The virgin space of the universe emerges, after which the successive influx of positron-electron pairs begins, and space expands. Simultaneously, time starts as a sequence of quantum time units, these changing with the size of the universe. The development of galaxies starts with the occurrence of the Cosmic Microwave Background radiation (CMB). The schematic principle is shown in **Figure 1**.

VARIABLE G

According to the Schwarzschild theory of black holes the equation for the event horizon is

$$r_S = \frac{2GM_u}{c^2}, \tag{1}$$

where G is the gravitational parameter, M_u is the total matter content and c the velocity of light. The real black hole radius r_u is half r_S and from **Figure 2** follows that the curvature radius is

$$r = \frac{GM_u}{2c^2}. \tag{2}$$

The radius of the virgin universe was derived in [6], we have

$$r_i = \frac{e^2}{4\pi\varepsilon_0 m_e c^2(2\pi - 1)} = \frac{r_e}{2\pi - 1} = 5{,}33379 \cdot 10^{-16}\, m, \tag{3}$$

where r_e is the electrostatic radius of the electron. The factor in the denominator is due to the curvature of space. The electron is considered a point-like particle, therefore $r_i < r_e$ is possible.

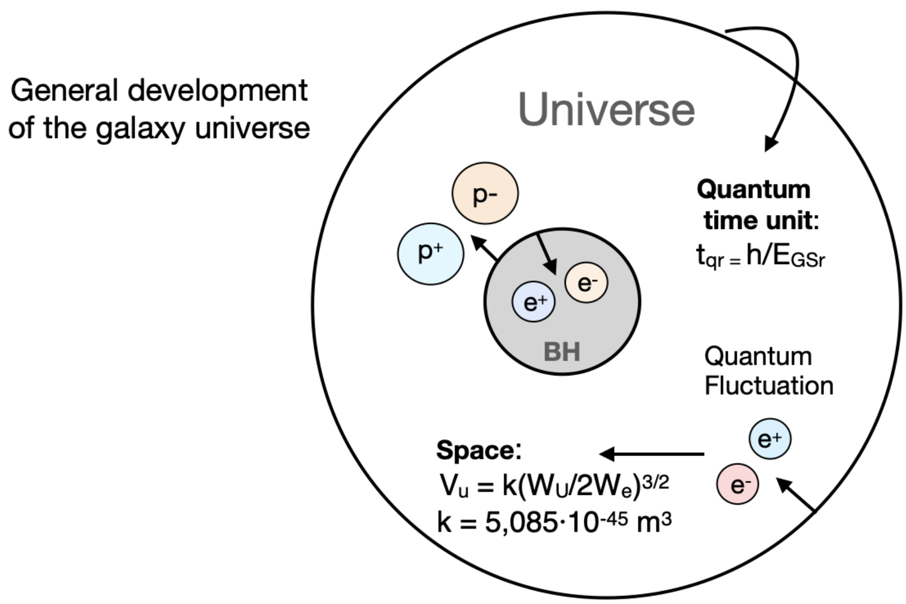

Figure 1: Origin of time, space and matter.

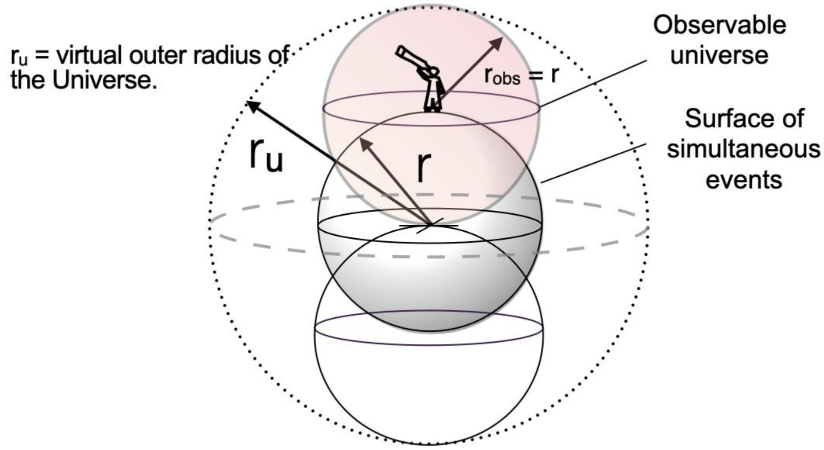

Figure 2: The geometry of the universe, r is the curvature radius and also the radius of the observable universe r_{obs} = r, r_u = 2 r.

It was also established that

$$G_i r_i = Gr = \frac{r_i^2 c^4}{W_e}, \tag{4}$$

where $W_e = m_e c^2$. The G(r) function is

$$G = \frac{r_i^2 c^4}{W_e} \frac{1}{r}. \tag{5}$$

The current value for the radius r_0 of the observable universe is obtained from Equation (5). Using G_0 = 6,674297·10^{-11} m^3/kgs^2, an estimated value for deep space [7], we have r_0 = 4,20551·10^{26} m. The value is slightly smaller than the Standard model 4,4·10^{26} m.

From Equation (2) and Equation (5) we obtain an equation for the real energy (ordinary matter and radiation) content

$$W_u = 2W_e \left(\frac{r}{r_i}\right)^2 = 4\pi b r^2. \tag{6}$$

Here b is a universal constant, for practical reasons defined according to Equation (6) by the author:

b = 4,58014·10^{16} J/m^2.

From Eq. (6) it is obvious that W_e is the quantum energy unit, $2W_e$ represents the pair of a positron and electron, e^+-e^-.

The total amount of matter and radiation can now be estimated

$$W_{u0} = 1{,}018\cdot 10^{71}\ \mathrm{J} \sim 1{,}133\cdot 10^{54}\ \mathrm{kg}.$$

The mass of the matter in the observable universe is $W_{u0}/8c^2 = M_{obs} = 1{,}416\cdot 10^{53}$ kg (Standard model: $1{,}5\cdot 10^{53}$ kg).

The Planck units will change with time, the only exception is the Planck charge q_P. We have the Planck length

$$\ell_P = \sqrt{\frac{hG}{2\pi c^3}} = \frac{1}{2\pi}\sqrt{\frac{hc}{br}}. \tag{7}$$

and the Planck energy

$$W_P = m_P c^2 = \sqrt{hcbr}. \tag{8}$$

Here h is the Planck constant. Notice that the Planck quantities are dependent on the size of the universe.

BLACK HOLES OR BODIES OF CREATION

Galaxy Centre Black Holes

The existence of black holes became concrete in 1916 when Karl Schwarzschild presented his theory of the event horizon for a celestial body with such mass that light could not escape. Black holes have since been shrouded by exotic theories such as being the loopholes to other universes. Here we assume that they are objects obeying known physical laws. The early universe had a low density until reaching a critical value, approximately when 1/6 of the positron-electron pairs have annihilated and the rest of the pairs agglomerate into a multitude of “small” high density black holes. The inner density of these black holes is so high that electrons and positrons are in a plasma state and not able to annihilate.

By combining the equations of G and $r_S/2$ we can calculate the relationship between the curvature radius r and the ratio r_{BH}/M_{RH}. We have

$$\frac{r_{BH}}{M_{BH}} = \frac{G}{c^2} = \frac{c^2}{2\pi br} = \frac{c^2}{2\pi bar_0}, \tag{9}$$

where r_{BH} is the radius and M_{BH} is the mass of the black hole, r_0 is the current curvature radius and also the radius of the observable universe, and a is the scale factor. The ratio decreases with increasing r, meaning that, if M_{BH} increases linearly with r then r_{BH} remains constant, but the black hole density increases.

According to Postulate 3, the inflow of positron-electron pairs into galaxy black holes increases its mass. On the outside proton-antiproton pairs are expelled following the Schrödinger ground state energy law, the equation of which is, cf. [8],

$$E_1 = \frac{h^2}{8m_e L_\psi}, \tag{10}$$

where L_ψ is the half-wavelength of the Schrödinger wavefunction. We presume $L_\psi = \ell_{Pi}/2$, where ℓ_{Pi} is the Planck length at the Initial Event. Considering Equation (7) the final ground state energy equation is

$$E_{GSi} = \frac{\pi hc}{r_i} = 4\nu_{pe}^2(2W_p). \tag{11}$$

Here $W_p = 1{,}50238 \cdot 10^{-10}$ J is the energy of the proton and $\nu_{pe} = 0{,}9863493$ is a factor connecting the ground state energy E_{GSi} to $8W_p$, notice, that lower letter p refers to the proton and P to Planck units. The value is $E_{GSi} = 1{,}1700129 \cdot 10^{-9}$ J.

Equation (11) implies that in parallel with the injection of positron-electron pairs into the black hole, 4 pairs of proton-antiproton pairs are ejected out of the black hole. This is a radical assumption, but later we will see that it leads to a solution close to the Standard model. Observations of the center of the Milky Way indicate high activity around the galactic black hole Sagittarius A*, much stronger than the Hawking radiation predicts.

The growth of matter around the galaxy black holes explains the accelerated expansion of the universe, see Section "The Accelerating Universe".

The Ground State As The Source Of The Quantum Time Unit

The universe black hole is a closed entity without any space on the outside. The ground state projects itself, not as a quantum energy state, but as the quantum time unit t_{qi} for the initial state and t_{qr} for an arbitrary curvature radius r. The quantum time unit is obtained from

$$t_{qi} = \frac{h}{E_{GSi}} = \frac{r_i}{\pi c}. \tag{12}$$

The value is

$$t_{qi} = 5{,}66324 \cdot 10^{-25} \text{ s}.$$

The derivation of the current quantum time unit t_{q0} is presented in the Section "The Quantum Universe", but we show the result already here

$$t_{q0} = t_{qi} \cdot \sqrt{(r_i/r_0)} = 6{,}3778 \cdot 10^{-46} \text{ s}.$$

The change of the quantum time unit has an impact on the propagation of light and thereby on the redshift, see Section "The Cosmic Microwave Background".

THE ACCELERATING UNIVERSE

The Expansion Process

The first observations of an accelerated expansion of the universe were made in the late 1990ies by two independent groups, cf. [9]. The result is significant, because it implies that either there is an unknown form of energy (dark energy) involved or the influx of new matter causes the rate change.

The Einstein Field Equation in its original form is

$$G_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}, \tag{13}$$

where $G_{\mu\nu}$ is the Einstein tensor and $T_{\mu\nu}$ is the energy-momentum tensor [10]. The Friedmann solution in Robertson-Walker metrics is, cf. [11],

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G\rho}{3} - \frac{kc^2}{{r_{cur}}^2}, \tag{14}$$

where $r_{cur} = r$ is the curvature radius, a is the scale factor and ρ is the density. The curvature factor k is -1, 0, +1 for negative, zero and positive curvature respectively, here +1. Notice that the cosmological constant term is left out.

We derivate Equation (14) with respect to time

$$2\dot{a}\ddot{a} = \frac{8\pi}{3}\left(Ga^2\dot{\rho} + 2G\rho a\dot{a} + \dot{G}\rho a^2 + \frac{3c^2\dot{a}}{8\pi r^2}\right). \tag{15}$$

Using the identities $\rho = \frac{3b}{8c^2 r_0 a}, G = \frac{c^4}{2\pi b r_0 a}$ we write

$$\frac{\ddot{a}}{a} = \frac{4\pi G}{3}\left(\frac{a}{\dot{a}}\dot{\rho} + 2\rho + \frac{\dot{G}}{G}\rho\frac{a}{\dot{a}}\right). \tag{16}$$

Equation (16) differs from the accustomed equation by accounting for the time derivative of G. The time derivative of the density, $\dot{\rho}$, contains the pressure p responsible for the expansion, as will be shown below. The 1. Law of Thermodynamics states that dW + pdV = 0. We have

$$\frac{dW}{dt} + p\frac{dV}{dt} = 0. \tag{17}$$

The rate of volume change is

$$\frac{dV}{dt} = \frac{32\pi}{3}\frac{d}{dt}(r^3) = 3V\frac{\dot{a}}{a}. \tag{18}$$

On the other hand, the change of work is

$$\frac{dW}{dt} = V\dot{\rho}c^2 + \rho c^2 \frac{dV}{dt} = Vc^2\left(\dot{\rho} + 3\rho\frac{\dot{a}}{a}\right). \tag{19}$$

Now, by combining Equations (18) and (19) with Equation (17) we have

$$\dot{\rho}\frac{\dot{a}}{a} = -3\left(\rho + \frac{p}{c^2}\right). \tag{20}$$

We may now write the complete equation of acceleration

$$\frac{\ddot{a}}{a} = -\frac{4\pi G}{3}\left[\rho\left(1 - \frac{\dot{G}}{G}\frac{a}{\dot{a}}\right) + 3\frac{p}{c^2}\right]. \tag{21}$$

Using the identities of r, G and p = - dW/dV = - $b/4r_0a$ the equation takes the form

$$\frac{\ddot{a}}{a} = \frac{c^2}{2r_0^2a^2}\left[\frac{1}{2}\left(\frac{\dot{G}}{G}\frac{a}{\dot{a}} + 1\right)\right]. \tag{22}$$

It is easy to show that, if the time derivative of G in the identity definition is $\frac{\dot{G}}{G}\frac{a}{\dot{a}}$ = -1, whereby Equation (22) is equal to zero, there is no acceleration. Acceleration requires that $\frac{\dot{G}}{G}\frac{a}{\dot{a}} \neq$ -1. We make the following Ansatz:

$$G = \frac{c^4}{2\pi b r_0 a^{(1-2B)}}, \tag{23}$$

where B is a new parameter, which will later be proven to be close to a constant over a wide range of a. The time derivative of G is

$$\frac{\dot{G}}{G}\frac{a}{\dot{a}} = -(1 - 2B). \tag{24}$$

The final acceleration equation is

$$\frac{\ddot{a}}{a} = \frac{c^2}{2r^2}B, \tag{25}$$

and the real acceleration of the expansion of the universe is

$$g_u = r_0\ddot{a} = \frac{c^2}{2r_0a}B = \frac{c^2}{2r}B. \tag{26}$$

Here g_u has been used as the symbol for acceleration because a is reserved for the scale factor. B can be considered the acceleration constant of the universe; its value is approximately 0,10. The current acceleration of the expansion is $g_{u0} = 1{,}069 \cdot 10^{-11}$ m/s^2.

The Hubble Parameter

Equation (25) is differentiated with respect to a, we have

$$\dot{a}d\dot{a} = \frac{1}{2}\frac{c^2}{r_0^2}B\frac{da}{a}. \tag{27}$$

By integration we obtain

$$\dot{a} = \frac{c}{\mathrm{r}_0}\sqrt{B\ln\left(\frac{r}{r_i}\right)} = \frac{c}{\mathrm{r}_0}\sqrt{B}\mathrm{L}. \tag{28a}$$

The Hubble parameter is

$$H = \frac{\dot{a}}{a} = \frac{c}{\mathrm{ar}_0}\sqrt{B\ln\left(\frac{r}{r_i}\right)} = \frac{c}{\mathrm{r}}\sqrt{B\mathrm{L}}. \tag{28b}$$

For B ≈ 0,10 and the current value L = $\ln(r_0/r_i)$ =96,471 we obtain H_0 = 68,31 km/sMpc.

Dark Matter Explained

The irregular rotation patterns observed in most galaxies is the reason for the addition of the dark matter concept into the Standard model. In the 1990s, a small but observable acceleration in the expansion rate was detected. Because of the acceleration, the Coriolis effect offers a less dramatic but reasonable solution to the problem [2].

It is surprising that physicists have missed the simple fact that an increase in the expansion rate means an increase in the kinetic energy of all matter. *There is no real input of kinetic energy, the increase is due to the expansion of space.* The kinetic energy must be considered as virtual, it is obtained from

$$W_{vKE} = \frac{1}{2}\frac{W_u}{c^2}\mathrm{v}_{exp}^2, \tag{29}$$

where v_{exp} = rH is the expansion velocity. When H from Equation (28b) is inserted, we have

$$W_{vKE} = \frac{1}{2}BLW_u. \tag{30}$$

Roughly BL ≈ π^2 leading to $W_{vKE} \approx 5 \cdot W_{u0}$, which is consistent with the Standard model. Similarly, acceleration causes a virtual increase in energy. The equation is

$$W_{vAcc} = \int mg_u dr = \int \frac{4\pi br^2}{c^2}\frac{c^2 B}{2r} dr = \frac{1}{4} BW_u. \tag{31}$$

Together, Equations (30) and (31) form the equation for dark matter

$$W_{vDM} = \frac{1}{4}(B + 2BL)W_u. \tag{32}$$

W_{vDM} equals W_c in the Standard model.

THE QUANTUM UNIVERSE

Quantum Fluctuations

Albert Einstein introduced the cosmologic constant Λ to prevent the equations of General Relativity from allowing the universe to expand. He later claimed that this was his "biggest blunder", the blunder being that he did not predict the expansion. The constant has been reintroduced to the equations to explain the continuous growth of space.

Here, we suggest another approach based on the proposal of Paul Dirac [5]. Matter did not enter at the Big Bang, but is continuously created on the edge of the galaxy black holes. The Schwarzschild equation says that the mass of a new body at the periphery, r, has a potential energy equal to its mass energy. Let M be the mass of the black hole, then $mc^2 = GMm/r^2$ or $c^2 = GM/r^2$. As a consequence, we suggest that positron-electron pairs drop into reality from quantum fluctuations. The probability of real matter evolving from fluctuations is obtained from the Planck energy of the Initial Event W_{Pi}. Using Equations (7) and (8) we have

$$W_{Pi} = \sqrt{hcbr_i} = \frac{1}{2\pi}\sqrt{\frac{hc}{br_i}\frac{4\pi br_i^2}{2r_i}} = \frac{\ell_{Pi}}{2r_i}(2W_e). \tag{33}$$

In conclusion, $2W_e = (2r_i/\ell_{Pi})\cdot W_{Pi} = p_{qf}\cdot W_{Pi}$, where $p_{qf} = 0{,}0743$ is the probability of a quantum fluctuation becoming real matter. On the universe scale the virtual dark energy is

$$W_{vDE} = \frac{\ell_{Pi}}{2r_i} W_u. \tag{34}$$

The numeric values are $W_{Pi} = 2{,}202904\cdot 10^{-12}$ J and $\ell_{Pi}/2r_i = 13{,}4534$, both are universal constants.

Connection between Moving Objects and the Curvature Parameter G

According to the Special theory of relativity, the energy state of an object set in motion, velocity v, changes with the increase in kinetic energy

$$\frac{W_0}{W_1} = \frac{W_0}{W_0 + W_{kin}} = \sqrt{1 - \left(\frac{v}{c}\right)^2}, \tag{35}$$

where W_0 is the mass energy in the reference state, W_1 is the moving state and W_{kin} is the additional kinetic energy. We claim that

$$\frac{W_0}{W_1} = \sqrt{1 - \left(\frac{\mathrm{v}}{c}\right)^2} = \frac{G_0}{G_1}. \tag{36}$$

Here G_0 is the curvature parameter for the reference state and G_1 the curvature parameter for the moving state. The solution to the Twin Paradox will prove that the claim is correct.

The Quantum Scheme and the Quantum Equation of the Universe

According to tradition, G is constant and consequently the Planck energy W_P is also constant. The variable G scenario must look for an alternative location for the ultimate Planck units. The solution is the Initial Event, where, according to Equation (8), the Planck energy is

$$W_{Pi} = \sqrt{hcbr_i} = 2.20290 \cdot 10^{-12} J.$$

The ratio between the current W_{P0} and W_{Pi} is

$$\frac{W_{P0}}{W_{Pi}} = \frac{1}{\sqrt{\frac{G_0}{G_i}}} = \sqrt{\frac{G_i}{G_0}} = \sqrt{\frac{r_0}{r_i}}. \tag{37}$$

The numerical value of the current Planck energy is W_{P0} = 1,95608·10^9 J.

The relation between the quantum time units t_{qi} and t_{q0} is obtained from

$$t_{q0} = t_{qi}\sqrt{\frac{G_0}{G_i}} = t_{qi}\sqrt{\frac{r_i}{r_0}}. \tag{38}$$

We can now visualize the relationships between, on the one hand, the current quantum state and reality, and, on the other hand, the Initial Event quantum state and reality, **Figure 3**.
The quantum equation of the universe is

$$W_Q = W_{Pi} + 2W_e + 2W_e\left(\frac{B}{4} + \frac{BL}{2}\right). \tag{39}$$

Here W_{Pi} represents virtual dark energy, $2W_e$ real energy (matter and radiation) and the last term virtual dark matter.

When Equation (39) is divided with 2We we have

$$\frac{W_Q}{2W_e} = 2BL = \frac{\ell_{Pi}}{2r_i} + 1 + \frac{1}{4}(B + 2BL). \tag{40}$$

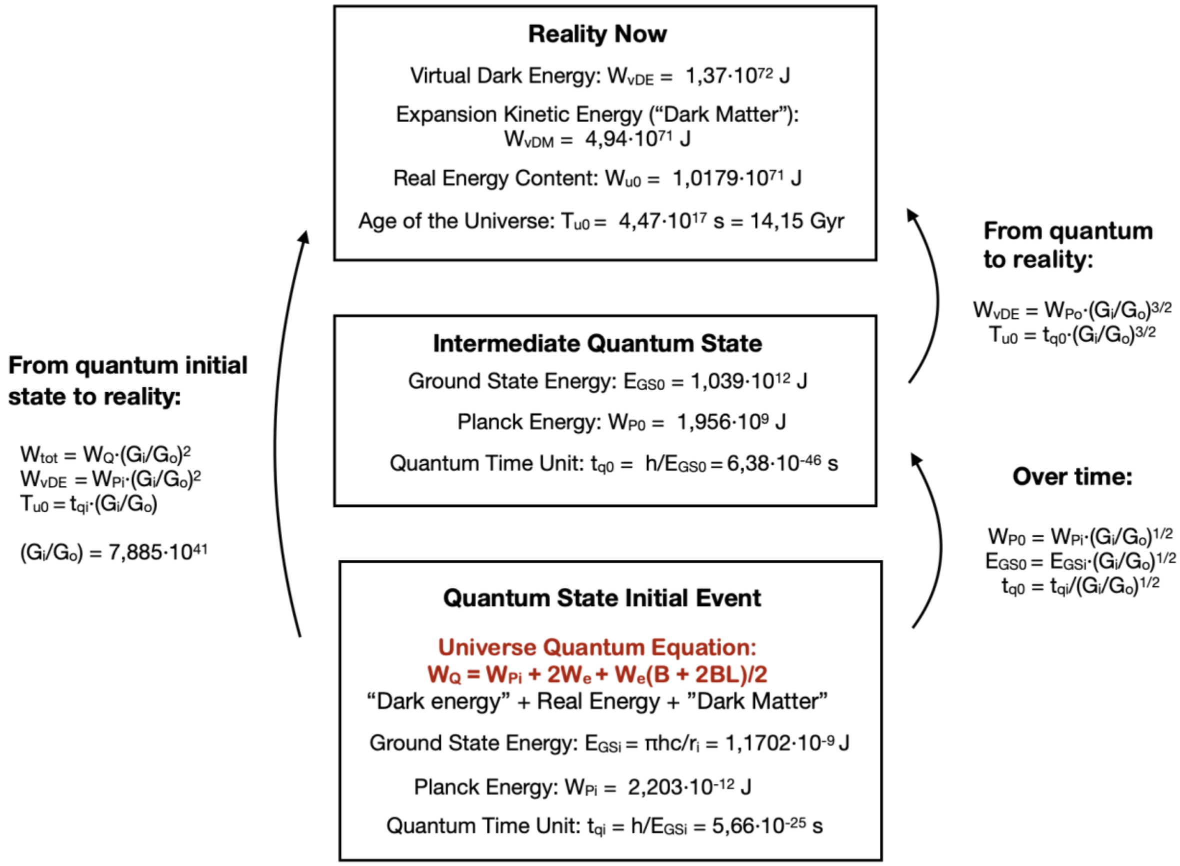

Figure 3: A schematic representation of the quantum states and the transformation operators from the Initial Event to the present quantum state and from the quantum states to the real world. (Notice that the Reality Now energy numbers are 8 times those of the observable universe.)

The equation emphasizes W_e:s role as an elementary quantum entity. When the current number for L = 96,471 and $\ell_{Pi}/2r_i$ = 13,4535 are substituted into the equation, we can solve B = 0,1005765. The Hubble parameter will be H_0 = 68,52 km/sMpc, a value consistent with the earlier approximate estimate.

The transformation formulas from the quantum states to the real-world state are shown in **Figure 3**. The ratio $G_i/G_0 = 7{,}88466\cdot10^{41}$ has an important function. It is actually the correct Dirac large number.

The Twin Paradox is the Key

In the original Special relativity paper Einstein comments the change of the time base between a moving clock A and a reference clock B: "Hieraus ergibt sich folgende eigentümliche Konsequenz" (This leads to the following peculiar consequence) [12]. The clocks are synchronized before the clock A is accelerated to a speed of v. The synchronisation is lost as soon as A is set in motion. The original German word "eigentümlich" refers rather to incomprehensibility than just peculiarity. In 1971 Hefele and Keating tested the paradox by flying an atomic clock around the world both eastbound and westbound. In accordance with the paradox, the test showed that time was delayed when clocks moved in relation to the clock on the Earth surface [13]. So far there has been no satisfactory explanation to the Twin Paradox. It is a matter of change of energy state. Acceleration brings the system to a higher energy level: rest mass + kinetic energy. The explanation to the Twin Paradox is not related to acceleration, the time of which can be very short compared to the longing of the travelling state.

The current theory (CBU) offers a comprehensive explanation of the Twin Paradox. Let the quantum time unit at the reference location R be t_{q0} and the number of units required for a certain time period N_0. At R we have

$$T_0 = N_0 t_{q0} = \frac{N_0 t_{qi}}{\sqrt{\frac{G_i}{G_0}}}. \tag{41}$$

In the travellers coordinate system $G = G_1$, time unit t_{q1} and the number of units required N_1. The time period is

$$T_1 = N_1 t_{q1} = \frac{N_1 t_{qi}}{\sqrt{\frac{G_i}{G_1}}}. \tag{42}$$

The ratio between the numbers of time units is obtained from

$$\frac{N_1}{N_0} = \left(\frac{G_0}{G_1}\right)^{\frac{3}{2}}. \tag{43}$$

We have the ratio

$$\frac{T_1}{T_0} = \sqrt{1 - \frac{\mathrm{v}^2}{c^2}} = \frac{t_{q1}}{t_{q0}} \frac{N_1}{N_0} = \left(\frac{G_1}{G_0}\right)^{\frac{1}{2}} \left(\frac{G_0}{G_1}\right)^{\frac{3}{2}} = \frac{G_0}{G_1}. \tag{44}$$

The equation proves that the ratio of compared time periods is tied to the ratio of respective curvature parameters G. It also proves that the hypothesis of Equation (36) is correct.

Equation (44) brings symmetry into the system, for any arbitrary time duration applies $G_1 T_1 = G_0 T_0$. Similarly, the symmetry also applies to the energy of moving bodies, Equation (36): $W_o G_1 = W_1 G_0$. *Equation (44) demonstrates the connection between Special relativity to General relativity.*

THE COSMIC MICROWAVE BACKGROUND

Redshifts

The gravitational parameter G is extremely large in the initial phase, $G_i \approx 5 \cdot 10^{31}$ m^3/kgs^2. The parameter decreases successively with the expansion. The photons of the Cosmic Microwave Background (CMB) are propagating faster than the expansion. We write the energy equation for electromagnetic radiation propagating in a gravitational gradient field.

$$hdf + g\frac{hf}{c^2}dr = 0, \tag{45}$$

where f is the frequency, g the gravitational acceleration along r. We obtain g from

$$g = \frac{GM}{r^2} = \frac{2c^2}{r}. \tag{46}$$

Here we made use of $M = 4\pi br^2/c^2$ and $G=c^4/2\pi br$. Having that $f = c/\lambda$, $df = -cd\lambda/\lambda^2$ and $r = r_0 a$, where a is the scale factor, we write

$$\int \frac{d\lambda}{\lambda} = 2\int \frac{da}{a}. \tag{47}$$

Integration implies that λ is proportional to a^2. We deduce that

$$\frac{\lambda_0 - \lambda_s}{\lambda_s} = \left(\frac{1-a}{a}\right)^2 = z_g. \tag{48}$$

Here z_g is the gravitational redshift, λ_S and λ_0 are the wavelengths at the source and at the observer respectively.

As known the cosmological redshift is

$$z_{cr} = \frac{1}{a} - 1. \tag{49}$$

The combined redshift is $z = z_g + z_{cr}$. We have

$$z = \frac{1-a}{a^2}. \tag{50}$$

The Origin of the CMB

It is broadly believed that positron-electron annihilation is the primary source of CMB photons. The alternative redshift paradigm of the previous section brings formally the CMB event closer to the present.

The energy density of the black body radiation we obtain from the classical Stefani-Boltzmann equation.

$$w_{BB} = \frac{8\pi^5 k_B^4}{15c^3h^3}T^4 = \alpha_B T^4. \tag{51}$$

Here $\alpha_B = 4\sigma_{SB}/c = 7{,}565723\cdot10^{-16}$ J/K^{4}m^3 is the density constant, σ_{SB} is the Stefani-Boltzmann constant, and k_B the Boltzmann constant. Given that the current CMB temperature is T_{CMB0} =

2,7255 K, we obtain an energy density of w_{BB} = 4,175·10^{-14} J/m^3. Accordingly, the total energy of the CMB radiation is 1,040·10^{68} J.

The number density of the photons is obtained from, cf. Wikipedia: Photon Gas,

$$n_{ph} = 16\pi\zeta(3)\left(\frac{k_B T}{hc}\right)^3, \tag{52}$$

where $\zeta(3)$ = 1,202056 is the Riemann zeta-function. By dividing Equation (51) with Equation (52) we obtain an expression for the photon energy.

$$W_{ph} = \frac{\pi^4 \alpha_B T}{16\zeta(3)}\left(\frac{hc}{k_B}\right)^3. \tag{53}$$

The current photon energy is W_{ph0} = 1,0165·10^{-22} J, a figure in accordance with the Standard model.

If we assume that the photon energy at the CMB transition event equals one of the two photons caused by the positron-electron annihilation, we have $W_{phc} = W_e$. From $W_{ph0} = a_c^2 W_{phc}$ we have

a_c = 0,00003523,

the scale factor of the CMB transition event. For vary small values of the scale factor the frequency of CMB photons decrease approximately according to

$$f_0 = \frac{a_c^2}{1 - a_c + a_c^2} f_c \approx a_c^2 f_c. \tag{54}$$

Here $f_c = W_e/h$ is the frequency of the original CMB radiation. The corresponding frequency f_0 = W_{ph0}/h = $a_c^2 W_e/h$= 153,4 GHz, slightly below the Planck black body spectrum optimum frequency of f_{max} = 160,23 GHz. The frequency value shows that the positron-electron annihilation is the plausible source of the CMB, and that the scale factor a_c is relevant.

The high redshift galaxies with z > 10 have caused conflicts with the Standard model. The age of these galaxies seems to be very close to the Big Bang event. As an example the redshift of GN-z11 is z = 10,6, according to Equation (50) the scale factor is a = 0,2636. The age of the universe when light was emitted is obtained from

$$t_{z11} = \frac{a r_0}{c\sqrt{B \ln \frac{a r_0}{r_i}}} = 1{,}19 \cdot 10^{17} s = 3{,}8\, Gyr.$$

Here B ≈ 0,1. Look-back time is 10,4 Gyr, there has been well enough time to develop a stellar sphere.

The Quantum Nature of the Photon

The quantum nature of time is reflected in its influence on the properties of the photon. We propose that the photon is an "energy composite" of quantum photon units, W_{qph}. As with the quantum time unit, the quantum photon unit depends on the age of the universe, i.e. the gravitational state.

The current value of the quantum photon unit is

$$W_{qph0} = E_{GSi}\frac{G_0}{G_i} = 1{,}4839109 \cdot 10^{-51} J, \tag{55}$$

where $G_0/G_i = 1/(7{,}885 \cdot 10^{41})$, see **Figure 3**.

For an arbitrary scale factor a the quantum photon unit, considering $G = G_0/a$, is

$$W_{qpha} = \frac{W_{qph0}}{a}. \tag{56}$$

Consequently, the quantum photon unit of the original CMB photons is

$$W_{qphc} = 4{,}2113489 \cdot 10^{-47} \text{ J}.$$

By combining Equations (12) and (38) we write the general equation of the quantum time unit.

$$t_{qa} = \frac{h}{E_{GSi}}\sqrt{\frac{G_0}{G_i}}\frac{1}{\sqrt{a}}. \tag{57}$$

The luminosity of an EM signal is dependent on change of the quantum unit t_q and the quantum photon energy unit W_{qph}. We will show that the energy, and luminosity, change follows the equation

$$\frac{W_{\gamma 0}}{W_{\gamma a}} = \frac{t_{qa}}{t_{q0}} \cdot \frac{W_{qa}}{W_{q0}} = \frac{1}{a}\frac{1}{\sqrt{a}} = \frac{1}{a^{3/2}}, \tag{58}$$

where $W_{\gamma a}$ and $W_{\gamma 0}$ are the energies of the source in a and the receiver respectively, i.e. the number of photons times the photon energies. The scale factor a is always less than 1, which means that the luminosity increases with distance. We test the validity of Equation (58) by calculating the expected current value of the CMB radiation. The source energy at the CMB event, $a_c = 0{,}00003523$, is $W_{CMBc} = c^2 W_{u0}/6 = 2{,}148 \cdot 10^{61}$ J. We have

$$W_{CMB0} = \frac{1}{a_c^{3/2}} W_{CMBc} = 1{,}027 \cdot 10^{68} J. \tag{59}$$

According to current data from the Standard Model, the relative density of the CMB energy Ω_{CMB} = 5,38·10^{-5} and the critical density ρ_{cr} = 8,5329·10^{-27} kg/m^3. From this follows that W_{CMB0} = 1,028·10^{68} J.

Equation (58) indicates a significant increase in the number of photons as they travel through the expanding universe. The primary source of this increase is the change in the quantum photon energy caused by the change in the G/G_i ratio. The equation applies to any source of EM radiation, at any arbitrary scale factor a.

Equation (58) explains why distance estimates based on luminosity differ from redshift measurements.

The timeline of the expansion of the universe is schematically presented in **Figure 4**.

COSMOS NOW

Galaxy Energy Content

According to the CBU theory, space expands when positron-electron pairs are created. Potential gravitational energy is the negative counterpart of the matter energy content. Some of the pairs annihilate, causing electromagnetic radiation.

In the previous section, the development of the current CMB radiation pattern was described. The black holes start to create new matter, on the one hand positron-electron pairs on the inside and on the other hand proton-antiproton pairs on the outside. Equation (11) implies that to every inside pair there is 4 pairs on the outside. Let $W_{Buc} = (1 - {}^{1}\!/_{6})W_c$ be the total black hole energy at the CMB transition event. Having $W_c = a_c^2 W_{u0}$, the current total black hole energy is

$$W_{Bu0} \approx 0{,}83 a_c W_{u0} = 2{,}98 \cdot 10^{66}\ J. \tag{60}$$

Using the implication of Equation (11) we write the equation of the total energy of the galaxies.

$$W_{Gu0} = \left[1 + 4(1 - a_c)\nu_{pe}^2 \frac{m_p}{m_e}\right] W_{Bu0}. \tag{61}$$

Here m_p/m_e (1836) refers to the ratio of the proton and the electron mass. The term $(1 - a_c)$ indicates that the growth of galaxy matter starts at the CMB transition. Approximately $W_{Gu0} \approx 4\nu_{pe}^2(m_p/m_e)\cdot W_{Bu0}$.

The total galaxy energy is

$$W_{Gu0} = 2{,}13\cdot 10^{70}\ \text{J or } M_{Gu0} = 2{,}37\cdot 10^{53}\ \text{kg}.$$

The matter and radiation energy (real energy) W_{u0} consists of three components.

$$W_{u0} = W_{DS0} + W_{Gu0} + W_{CMB0}. \tag{62}$$

Here W_{DS0} is the energy produced by the positron-electron pairs emerging in deep space after the CMB transition. We have

$$W_{DS0} = 8{,}04 \cdot 10^{70}\ \text{J}.$$

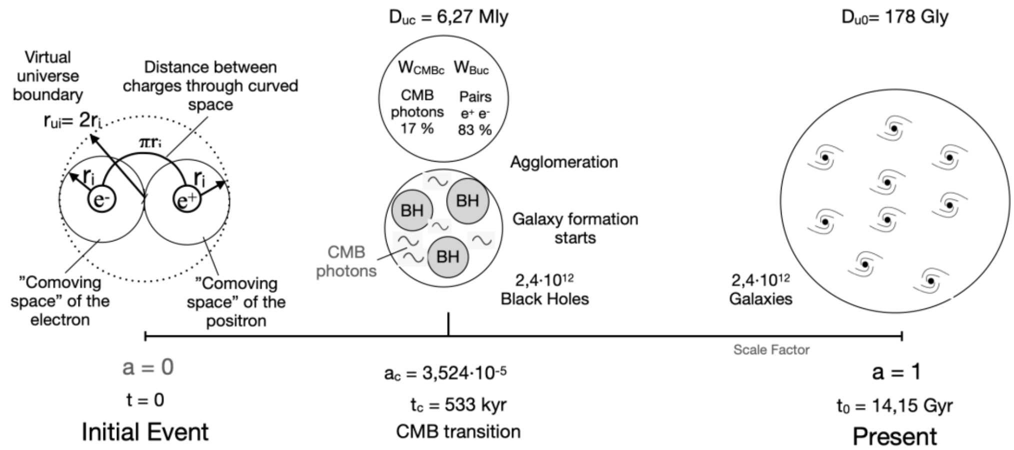

Figure 4: The universe evolved from a positron-electron pair that "popped up" from a quantum fluctuation. After about 533,000 years, a transition occurs due to pair annihilation, one sixth continuing as radiation (CMB), while the rest forms a multitude of high-density black holes, the centers of the galaxies that will become.

The number density of electrons, as well as for positrons, is $200/\text{m}^3$. The order of magnitude is right, but there are no reliable methods for confirmation in the far-out space.

To determine the number of galaxies we must use an intelligent guess on the average mass of a galaxy black hole, $M_{BH0} \approx 1{,}4 \cdot 10^{37}$ kg, say. The number of black holes, and galaxies, is then $N_G \approx 2{,}4 \cdot 10^{12}$. The average mass of a galaxy is $M_{G0} \approx 1{,}0 \cdot 10^{41}$ kg. Traditional astrophysics includes dark matter resulting in a 6-time higher value, $M_{G0av} = 6 \cdot 10^{41}$ kg.

The result of the reasoning above is shown in a diagram by astrophysicists Sandra Faber and Sofia Quiros, **Figure 5**, [14], [15]. The relation between the black hole mass and the galaxy mass is obvious. The line of Equation (61) matches the suggested marking of the Milky Way.

This may be seen as the strongest argument for Postulate 3.

Virtual and Real Energy

Virtual means a quantity that is significant for the understanding of a theory but does not exist in the real world. Planck energy represents the quantum fluctuation particles that pop in and out of reality, only allowing a small portion to become real. Dark energy is Planck energy. Equally, dark matter is a virtual form of kinetic energy, when space expands particles gain a higher velocity and thereby gain another state of energy, without putting extra energy into the change of state.

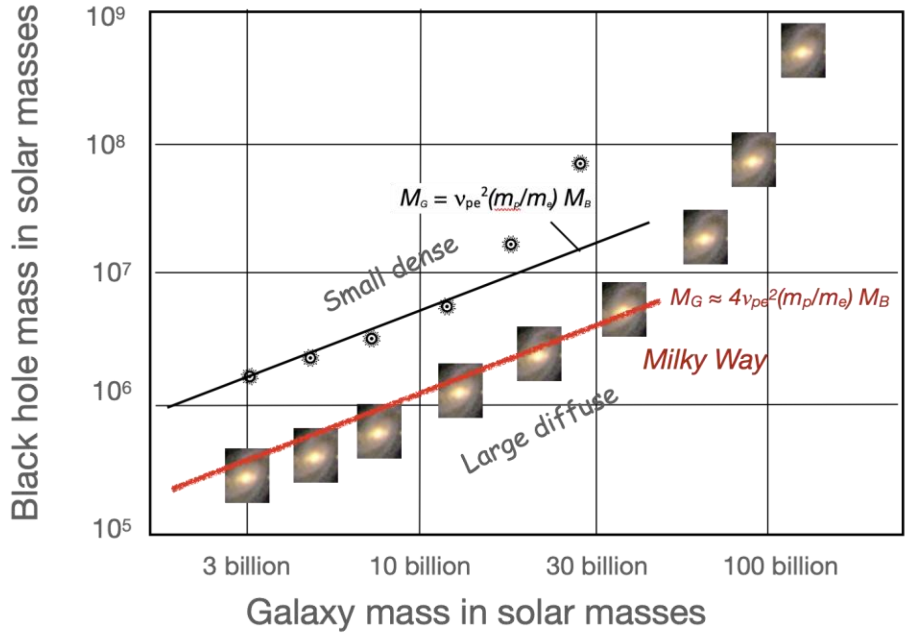

Figure 5: A reproduction of a diagram, created by Sandra Faber and Sofia Quiros, presents the relation between black hole and galaxy stellar masses. Also, in the picture the theoretical curves based on the presumption that baryonic matter is produced by the black hole.

The mass energy of the electron, W_e, is the quantum unit of real energy. The total real energy is $W_{u0} = 2W_e(G_i/G_0)^2 = 1{,}018\cdot10^{71}$ J, Equation (6). The virtual dark energy is $W_{vDE} = W_{u0}\cdot(\ell_{Pi}/2r_i) = 1{,}369\cdot10^{72}$ J, Equation (34) and the virtual dark matter energy is $W_{vDM} = W_{u0}(B + 2BL)/4 = 4{,}94\cdot10^{71}$ J, Equation (32). The energy sum is $W_{tot} = 1{,}965\cdot10^{72}$ J. Notice that $(W_{tot}/2W_e)(G_0/G_i)^2 = 2BL = 19{,}3$, cf. Section "The Quantum Universe".

The critical density is $\rho_{cr} = W_{tot}/(c^2V_0) = 8{,}77\cdot10^{-27}$ kg/m³, or

$$\rho_{cr} = \frac{3H_0^2}{8\pi G_0} = 8{,}767\cdot10^{-27}\,\frac{kg}{m^3}. \tag{63}$$

The Standard model ρ_{cr} depends on the Hubble parameter, for $H_0 = 67{,}4$ km/(sMpc) the critical density is $8{,}53\cdot10^{-27}$ kg/m³.

A comparison between the relative densities, $\Omega = \rho/\rho_{cr}$, of the CBU theory and of the Standard model is presented in **Table 1**. In general, considering the different approaches, conformity is very good.

Table 1: Relative density: CBU versus the Standard model.

RELATIVE dENSITY	Ω_{u0} (Ω_b)	Ω_{vDE} (Ω_Λ)	Ω_{vDM}(Ω_c)
CBU	0,0512	0,697	0,251
STANDARD MODEL	0,0493[a)]	0,686	0,266

[a)] baryonic matter, smaller than the total real of CBU

CONCLUSIONS

The principle that a universe creates its energy by balancing negative potential energy with real matter energy, proposed by Paul Dirac in the 1974, has been analyzed and developed by the present author over a period of several years. Some errors have been corrected and open questions have been resolved, such as the determination of the acceleration factor B.

It is hardly a coincidence that the connection between galaxies and black holes, according to leading astrophysicists, perfectly correlates with the postulate that baryonic matter originates from the black hole. The agreement between the relative densities proves that the interpretation of the cause of dark energy and dark matter is the most likely one.

The study will lead to new insights in astrophysics, in particular the quantum time unit and possibly the quantum photon unit will offer opportunities to penetrate quantum mechanics from completely new angles.

Competing interests

The author declares that there are no competing interests.

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APPENDIX

Nomenclature

a, scale factor

a_c, scale factor of the CMB event

B, factor determining the acceleration of Universe expansion

b, universal energy constant, J/m^2

c, velocity of light, m/s

E_1, Schrödinger ground state energy, J

E_{GSi}, ground state energy at the Initial Event, J

F, frequency, Hz

G, gravitational (curvature) parameter (Newton's constant), m^3/kgs^2

G_0, curvature parameter at the reference site

G_1, curvature parameter of a moving object,

G_i, gravitational parameter at the Initial Event (creation), m^3/kgs^2

$G_{\mu\nu}$, the Einstein tensor of the Theory of General Relativity

g_u, acceleration of Universe expansion

H, Hubble parameter, s^{-1} or km/sMpc

H_0, current Hubble parameter, s^{-1} or km/sMpc

h, Planck constant, s

L, ln(r/r_i)

ℓ_{Pi}, Planck length, m

m_e, electron mass, kg

M_{BH}, mass of a black hole, kg

MG0, current av. mass of a galaxy

M_u, total real mass of the Universe, kg

N_0, N_1, number of time units in the Twin paradox, reference-traveler

N_G, total number of galaxies

n_{ph}, number density of a photon gas

p, pressure, N/m^2

p_{qf}, probability that a particle enters the real world from a quantum fluctuation

r, r_{obs}, radius of the observable Universe, also curvature radius, m

r_{BH}, radius of a black hole, kg

r_e, electrostatic radius of the electron, m

r_i, curvature radius of the Universe at the Initial Event (creation), m

r_o, current radius of the observable Universe, m

r_S, Schwarzschild radius, m

r_u, the outer radius of the Universe, m

T_0, T_1, time span units in the Twin paradox, reference-traveler

$T_{\mu\nu}$ energy-momentum tensor of the Theory of General Relativity

t_{qi}, quantum time unit at the Initial Event, s

t_{q0}, current quantum time unit, s

V, volume, m^3

V_0, the current volume of the University, m^3

w_{BB}, energy density of a Black Body, J/m^3

W_0, energy state at a reference site, J

W_1, energy state of a moving object, J

W_{Bu0}, current total black body energy, J

W_c, total real energy at the CMB event, J

W_{CMB0}, W_{CMBc}, energy of the CMB radiation, receiver/source, J

W_{DS0}, current real energy of the deep space, J

W_e, electron mass energy, J

W_{Gu0}, current total galaxy energy, J

W_{vAcc}, virtual energy of acceleration, J

W_{vDM}, virtual darmatter energy, J

W_{vKE}, virtual kinetic energy, J

W_P, Planck energy, J

W_p, proton mass energy, J

W_Q, total quantum energy at the Initial Event, J

W_{qph}, quantum photon unit, J

W_u, total real energy of the Universe, J

W_{u0}, current total real energy, J

$W_{\gamma a}$, $W_{\gamma 0}$, luminosity of a star/galaxy, receiver/source, J

z, redshift

z_g, gravitational redshift

z_{cr}, cosmological redshift

ε_0, permittivity constant,

λ, wavelength

ν_{pe}, adaptation factor of m_p/m_e

ρ, matter density, kg/m^3

ρ_{cr}, critical matter density, kg/m^3

Ω_{u0}, Ω_b, relative density of real matter, J

Ω_{vDE}, Ω_Λ, relative density of virtual dark energy, J

Ω_{vDM}, Ω_c, relative density of virtual dark Matter, J