

Cycle towards Methodology of Everything

Innovated version

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Abstract: This is innovated version of Article [21],

[http://gsjournal.net/Science-Journals/%7B\\$cat_name%7D/View/6283..](http://gsjournal.net/Science-Journals/%7B$cat_name%7D/View/6283..)

The difference here is that typos in some formulas after (41) have been corrected. Article presents the original methodology used for determining relationships between the parameters of the Universe, the whole and its parts. The assumption applied is that of the fundamental importance of mathematical constant $e^{2\pi}$, which we call the Cycle, showing its application in predictions in physics. The article proposes and presents the application of the original Table with three properties of matter (mass, length and time). The methodology is relational, it is in accordance with Mach's principle. The obtained results are in accordance with the official CODATA values [1]. This article is the expansion of the one published in the 2015 FQXi essay contest on the topic "*Trick or Truth: the Mysterious Connection between Physics and Mathematics*".

Keywords: Planck, Universe, Cycle, opposite, proton

1. Introduction

The objective is to obtain mathematical relations which connect the levels of the structure of matter. This can be achieved by connecting fundamental parameters of the Universe with the basic micro world parameters, using the fundamental mathematical and physical constants.

We can apply the widely-accepted fact that the following physical constants are universal: c – the speed of light, G – the universal gravitational constant, h – the Planck constant and, e – the elementary charge. The structures of organization of matter will be shown in three columns in the Table (mass, length and time) with an arbitrary number of rows (levels).

The mathematical approach and methodology applied in this paper contain widely-accepted and proven postulates, in such a way that old paradoxes are rejected and new ones are not produced.

2. Basis

Let's use the fact that the following relation is universally true: $h\nu=mc^2$ (m – mass, ν – frequency). Let's make a table, which you can see in Section 4 – Table, applying the above-mentioned relation at every level, i.e. row of the Table. The Table features three key properties of matter in a narrow sense (substance): mass, length and time, all three of which are contained in h – the Planck constant:

$$h = mc^2 / \nu \quad (1)$$

which is dimensionally $[ML^2T^{-1}]$. To comply with everything mentioned above, plus the dimensions of the Planck constant, there is the Table in Section 4, so that on every level n :

$$h = m_n c^2 t_n \quad (2)$$

One special example that has dimensions $[ML^2T^{-1}]$ is:

$$h = c * m_p * \lambda_p = (\lambda_p / t_p) * m_p * \lambda_p = m_p * \lambda_p^2 / t_p \quad (3)$$

Notice that the entire calculation could have been simpler if the Planck constant had been perceived as the product of mass, area and frequency or force, length and time [FLT]. Here the decision has been made to use mass, length and time as properties most familiar to us.

Hence, let's define the relation between the Whole and a part for the mass, radius and time:

$$m_n = M_u * 2^{-n} \quad (4)$$

$$r_n = R_u * 2^{-n/2} \quad (5)$$

$$t_n = \lambda_n / c \quad (6)$$

Or using (2):

$$t_n = \lambda_n / c = h / m_n c^2 = \lambda_p m_p c / m_n c^2 = t_p * 2^{n-p} \quad (7)$$

Where M_u and R_u are the mass and the radius of the Universe, m_n , r_n and λ_n are the mass, the generalized radius and the Compton wavelength of any structure level. The exponent n is any number different for the levels in the hierarchy of matter. For different n (structures), in order to shorten the formulas, one or two letters will be used, for example p for proton, instead of n_p .

Let's use the CODATA [1] values of physical constants, with uncertainty in brackets:

| | |
|---------------------------------|------------------------------|
| inverse fine-structure constant | $\alpha=137.035999074(44)$, |
| proton-to-electron mass ratio | $\mu=1836.15267245(75)$. |

The values determined through $\hat{\alpha}, \mu$ are presented with twelve significant digits, i.e. the number of digits of the input values. Uncertainties of physical quantities obtained through the formulas from the Table, are not presented here.

To define system of units of measurement, we are using c, λ_p, m_p in [kg-m-s]: the speed of light $c=2.99792458*10^8$ m/s, the proton mass $m_p=1.672621777*10^{-27}$ kg and the proton Compton wavelength $\lambda_p=1.32140985623*10^{-15}$ m.

Mathematical constants π, e and values derived from them are presented with 15 significant digits, as that is the limit in the software used ($\pi=3.14159265358979, e=2.71828182845905$).

Now we are wondering in which domain to distribute the levels of the Universe structures. It is evident that $n=0$ is the Universe as a whole, so "0" is the start of the domain, where mass of about 10^{53} kg is the one most commonly referred to in the literature.

The upper limit of the domain is more difficult to determine. Let's use the proton for which it is said that there are about 10^{80} in the Universe and let's apply that the relation of the mass of the Universe to the proton mass is approximately 10^{80} . The following is true for that relation $n \approx \log_2(10^{80}) = 265.7$. If the proton mass is close to the geometric mean of the mass of the Universe and imagined mathematical minimum mass $m_p \approx \sqrt{M_u * m_{min}}$, it means that the upper domain limit, which we can label as cy , is $cy \approx 2 * 265.7 = 531.4$.

Let's ask ourselves what is mathematically significant in proximity to the number 531.4? The answer is the numbers $2^9=512$ and $e^{2\pi}=535.491655524765$. The latter number is not only closer to 531.4, it is also mathematically more significant. The basis of natural logarithm e can be treated as the growth limit of each separate structure of the organization of matter. Therefore, we will use the domain $n [0, e^{2\pi}]$ for the purpose of obtaining a meaningful and experimentally confirmed value of the relations among different structures of matter. Let's call the mathematical constant Cycle (8) and then let's say:

Hypothesis 1 - Cycle has important role in the relationship of physical values

$$cy = e^{2\pi} = 535.491655524765 \quad (8)$$

If we calculate for the exponent value $n=cy/2$ the relation $M_u/m_{cy/2}=2^{cy/2}=3.97672E+80$, we can see that it is a dimensionless number, somewhat larger than the number of protons in the Universe, which is a value commonly mentioned in the literature. Therefore, we can say that for the proton in formula (4), the exponent p is close to the Half Cycle, $cy/2$. Let's emphasize that p is here connected to the relation between the mass of the Universe and the proton mass, $p=\log_2(M_u/m_p)$, and not to the number of protons in the Universe. Therefore, we can write the formula:

$$p = cy / 2 - \Delta p \quad (9)$$

Let's define the dimensionless θ :

$$\theta = \mu / \alpha' = 13.399053424 \quad (10)$$

Please note that the same is obtained from the relation between the classical electron radius and proton Compton wavelength:

$$\frac{r_{er}}{\lambda_p} = \frac{h}{2\pi\alpha' cm_{el}} / \lambda_p = \frac{m_p \lambda_p c}{2\pi\alpha' c \lambda_p m_{el}} = \frac{m_p}{2\pi\alpha' m_{el}} = \frac{\mu}{2\pi\alpha'} \quad (11)$$

Thus:

$$2\pi \frac{r_{er}}{\lambda_p} = \frac{\mu}{\alpha'} = \theta \quad (12)$$

Let's say that Δp is the proton shift and:

Hypothesis 2 - we assume that (13) is true:

$$\Delta p = 1 + \frac{\theta + 1}{\theta + 2} = 2 - \frac{1}{\theta + 2} = 1.9350609435 \quad (13)$$

For now, let's say that formula (13) is the result of the author's intuition, while more detailed explanation for Δp can be found in Appendix.

We will show that many simple and worthwhile relations of physical quantities are obtained when:

$$p = cy / 2 - \Delta p = 265.810766819 \quad (14)$$

It is possible to present physical quantities in one of the systems of natural units of measurement [2]. In papers [3] and [4], the applied system of natural units of measurement is defined in such a way that the mass, radius and cycle of the Universe equal 1, so that every structure is expressed as part of the ultimate whole, i.e. a unit, ("1"). Only in order for the results to be more visible, they will be presented here in [kg-m-sec]:

3. Calculations

The mass of the Universe, for $n=p$ according to the definition from (1) is:

$$M_u = m_p * 2^P = 1.73944911962 * 10^{+53} \text{ kg} \quad (15)$$

Let's calculate the Planck constant:

$$h = c * \lambda_p * m_p = 6.62606957321 * 10^{-34} \text{ kg m}^2 \text{ s}^{-1} \quad (16)$$

Let's call the time required to travel the proton Compton wavelength at the speed of light the proton time:

$$t_p = \lambda_p / c = 4.40774883086 * 10^{-24} \text{ s} \quad (17)$$

Let's define the opposite radius \underline{r} as the opposite of the generalized radius from (5) (more about the opposite in Part 6):

$$\underline{r}_n = R_u * 2^{-(cy-n)/2} / \sqrt{2\pi} \quad (18)$$

We have that $\underline{r}_n * r_n = R_u * 2^{-cy/2} / \sqrt{2\pi}$ which corresponds to the definition of the opposite. It is evident that the square of the opposite radius defined in this way multiplied with mass on every level gives the same constant value (independent from n).

$$m_n * \underline{r}_n^2 = M_u * 2^{-n} * R_u^2 * 2^{-(cy-n)} / 2\pi = M_u * R_u^2 * 2^{-cy} / 2\pi \quad (19)$$

By dividing (19) with the proton time t_p , we get a general formula for the Planck constant (20).

$$h = m_n * \underline{r}_n^2 / t_p \quad (20)$$

Or by substitution with (4) and (18):

$$h = M_u * R_u^2 * 2^{-cy} / 2\pi t_p \quad (21)$$

From (20), using the values from (8), (15), (16) and (17), we get the radius of the Universe (22):

$$R_u = \sqrt{2\pi t_p h / M_u * 2^{-cy}} = \lambda_p \sqrt{2\pi * 2^{cy-p}} = 1.29165299385 * 10^{26} \text{ m} \quad (22)$$

and the Time Cycle of the Universe (hereafter referred to as "Time Cycle"):

$$T_u = R_u / c = 4.30849062205 * 10^{17} \text{ s} \quad (23)$$

It is evident that the Time Cycle has the time dimension, while the earlier defined Cycle is a dimensionless quantity.

Specifically for the case of the proton, the general formula (20) transforms into:

$$h = m_p * \underline{r}_p^2 / t_p = m_p * \lambda_p^2 / t_p \quad (24)$$

From which we can see that only for the proton the opposite radius is equal to the Compton wavelength:

$$\underline{r}_p = \lambda_p \quad (25)$$

The opposites are largely discussed in philosophy, while their application in physics has been scarce. I think that beliefs of Stevan Bošnjak on the topic of application of opposites in physics are useful. For more information, see Part 6 and visit the website [5].

Notice that for the purpose of clearer representation, at every level we defined three quantities with the length dimension. Those are: the generalized radius r , the opposite radius \underline{r} and the Compton wavelength λ (connected to time with constant c , $\lambda_n = c * t_n$).

Let's also say that the product of the opposites is constant, while according to Bošnjak the opposites are both the mass and radiation. That is also seen here in (7), from which:

$$m_n * \lambda_n = h / c \quad (26)$$

Then (16) can also be written in the general form:

$$h = m_n * \lambda_n * c \quad (27)$$

The product of the opposites applied to the generalized radius and opposite radius is:

$$r_n * \underline{r}_n = R_u * 2^{-n/2} * R_u * 2^{-(cy-n)/2} / \sqrt{2\pi} = R_u^2 * 2^{-cy/2} / \sqrt{2\pi} = 1.67369533364E - 29 \text{ m}^2 \quad (28)$$

Previous results can be considered as an explanation for the fact that the proton is the most stable and widespread complex particle. We can see that at the level p there are the properties of mass, radius and time, existing in a unique which does not stand true for any other composed particle.

4. Table

Let's check the formula (20) by using (15), (22), (8) and (17):

$$h = M_u * R_u^2 * 2^{-cy} / 2\pi t_p = 6.62606957321E - 34 \text{ kg m}^2 \text{ s}^{-1} \quad (29)$$

Then, let's calculate the universal gravitational constant by using (15) and (22):

$$G = c^2 * R_u / M_u = 6.67383601087 * 10^{-11} \text{ kg}^{-1} \text{ m}^3 \text{ s}^{-2} \quad (30)$$

CODATA [1] values are: $h=6.62606957(44)*10^{-34} \text{ kgm}^2\text{s}^{-1}$, $G=6.67384(80)*10^{-11} \text{ kg}^{-1}\text{m}^3\text{s}^{-2}$

Now let's define a large dimensionless number N and call it the number of Planck's oscillators:

$$N = 2\pi R_u M_u c / h = 6.38707718369 * 10^{121} \quad (31)$$

Or:

$$N = (2\pi)^{3/2} 2^{(cy+p)/2} = 6.38707718369 * 10^{121} \quad (32)$$

Application of the number N for calculating parameters f and q , as well as certain exponents n can be seen in the Table.

Table – Relationships of the Universe and Its Parts

| 1 | 2 | 3 | 4 | 5 | 6 |
|--|-----------------------|-------------------------|--------------------------|--------------------------|---|
| Exponent | $n = \log_2(M_u/m_n)$ | Generalized radius (m) | Mass (kg) | Time (s) | In Excel notation E+53 is 10^{53} |
| Structure, formulas | calculated n | $r_n = R_u 2^{-n/2}$ | $m_n = M_u 2^{-n}$ | $t_n = t_p 2^{n-p}$ | Note and CODATA values |
| Universe | 0 | 1.2916529939E+26 | 1.73944911962E+53 | 4.2384089301E-104 | $M_u = m_p 2^p$, $R_u = \lambda_p (2\pi 2^{cy-p})^{0.5}$ |
| $tp = q/2 - \log_2 2\pi$ | 199.662731554 | 1.1452762324E-04 | 1.36754150464E-07 | <u>5.39105881400E-44</u> | $t_p = 5.39106(50) * 10^{-44} s$ |
| $g = q/2$ | 202.314227683 | 4.5689911183E-05 | <u>2.17650990346E-08</u> | 3.38730215303E-43 | $m_p = 2.17651(13) * 10^{-8} kg$ |
| $ne = p - q / (1 + \alpha^2 \log_2 \mu)$ | 265.808779550 | 1.2674708421E-14 | <u>1.67492735099E-27</u> | 4.40168146859E-24 | $m_{ne} = 1.674927351(74) * 10^{-27} kg$ |
| proton $p = cy/2 - \Delta p$ | 265.810766819 | <u>1.2665981934-14</u> | <u>1.67262177701E-27</u> | <u>4.40774883086E-24</u> | $m_p = 1.672621777(74) * 10^{-27} kg$ |
| $z = cy/2$ | 267.7458277624 | <u>6.4771382928E-15</u> | <u>4.37407634997E-28</u> | 1.68549794110E-23 | Half Cycle level |
| *1 $f = 2q/3$ | 269.752303577 | 3.2313088257E-15 | <u>1.08862161599E-28</u> | 6.77232251662E-23 | <u>Fundamental mass</u> |
| *2 $er = 2 \log_2(R_u/r_{er})$ | 270.147258734 | <u>2.8179403270E-15</u> | 8.27910907560E-29 | 8.90493966772E-23 | $r_{el} = h/2\pi\alpha m_e c$ |
| $el = p + \log_2 \mu$ | 276.653237125 | 2.9558641409E-16 | <u>9.10938290651E-31</u> | 8.09329979620E-21 | $m_{el} = 9.10938291(40) * 10^{-31} kg$ |
| *3 $kh = q - \log_2(2\pi)$ | 401.9769592365 | 4.0512095420E-35 | 1.71115532766E-68 | <u>4.30849062204E+17</u> | <u>Time Cycle</u> |
| *4 $q = \log_2 N$ | 404.628455366 | <u>1.6161987731E-35</u> | <u>2.72338828795E-69</u> | 2.70710449725E+18 | $t_p = 1.616199(97) * 10^{-35} m$ |
| *5 $e = q + \log_2 \alpha$ | 411.726866492 | 1.3806304181E-36 | 1.98735245216E-71 | 3.70970769379E+20 | Elementary charge |
| $cy = e^{2\pi}$ | 535.4916555248 | 3.2480333854E-55 | 1.0999197217E-108 | 6.70275888025E+57 | Cycle |

*1 The fundamental mass has a simple relation (33), see calculations [6, page 3]. $m_f^3 = \hbar^2 / (T_u Gc) \quad (33)$

*2 er is calculated by using the formula for the classical electron radius: $r_{er} = h / 2\pi\alpha' m_e c \quad (34)$

And then: $er = 2 \log_2(R_u / r_{er}) \quad (35)$

*3 At the kh level, there is the photon with the smallest mass and appropriate time t_{kh} needed for the radius of the Universe to be traveled at the speed of light, with an equal Time Cycle $t_{kh} = Tu$. There, the number of quantum mechanical oscillators is $N_0 = 2^{kh} = N/2\pi = M_u R_u c / h = 1.016535E+121$.

*4 At the q level, the generalized radius is actually the Planck length. The assigned mass is the hypothetical mass quantum [7, Table 1]. Number $N = 2^q$ we call the number of Planck oscillators, which is 2π times larger than the number of **quantum mechanical oscillators** at the kh level.

*5 Level e is responsible for electrical phenomena, and the following applies:

$$e = el + er / 2 = mu + mr / 2 = tu + tr / 2 = 411.726866492 \quad (36)$$

Where mr and tr for the classical muon and the tau lepton radius have been determined in the same way as er in (34), (35).

From the levels kh and q we can conclude that real masses are at the levels lower than kh , while Planck's level q for the final value $\log_2(2\pi)$ is greater than kh . That discontinuity with precisely defined gaps justifies that in physics gaps are just as important as fullnesses.

Planck's levels and their corresponding values should not be viewed as boundaries, rather as frames within which material particle processes are taking place.

Since there always is a finite gap in-between fullnesses, it can be concluded that the application of differential calculus and integrals in physics is to a very limited extent possible, with constant alertness that instead of $dx \rightarrow 0$ there is always some finite Δx , which can have finitely small values, but it can also be very large. In [8], author Temur Z. Kalanov comprehensively and critically explains that topic of (mis)use of integrals and differentials in physics.

5. Some Significant Relations

The Table presents the calculation of relationships between the Whole and its parts and it is a crucial methodological innovation in presenting physical quantities, as it provides a well-laid-out representation of the relations that exist among them.

For each structure level, values for r , m and t have been calculated according to the formula in the Table header. Whether it is an elementary, complex or virtual particle, a planet, a star or the Universe as a whole, each level has been assigned a certain mass, radius or time, regardless of whether they have a known physical meaning. The point with the Table is that, besides the values of physical quantities, their mutual relations are important as well. Another advantage is that each significant radius has its corresponding mass (for example, see the classical electron radius in the Table), allowing us to compare the parameters of the same property. If the relation to the defined or previously determined physical quantity is known, the formula can be found in the first column. The values which are underlined are those most commonly found in the literature. The last column contains the description of physical phenomena presented in each level, although it should be noted that one row can contain several significant quantities.

In the Table, structure levels are ordered according to the ascending n . The Table enables the calculation of h , G and e by three properties (r , m and t) for each n , i.e. on every level, by equations (23-26):

The Planck constant:

$$h = c^2 m_n t_n = 6.62606957321 * 10^{-34} \text{ kgm}^2 \text{ s}^{-1} \quad (37)$$

The universal gravitational constant:

$$G = c^2 2^{-n/2} r_n / m_n = 6.67383601087 * 10^{-11} \text{kg}^{-1} \text{m}^3 \text{s}^{-2} \quad (38)$$

Elementary charge:

$$e = \sqrt{10^9 c^3 m_n t_n / 2\pi\alpha'} = 4.80320450501 * 10^{-10} \text{statC} \quad (39)$$

The CODATA [1] value for e is: $e=4.80320427(12)*10^{-10}$ statC

Because of the way statC is defined, coefficient in formula (39) is 10^9 and it really does seem rough and unnecessary. The destiny of every scientific paper that merges phenomena from different fields is that it faces confusion in the system of measurement, hence not even [kg-m-sec] system has a unified presentation in cosmology, thermodynamics and electrostatics.

From the way the Planck mass ($m_{pl} \equiv n_g$), length ($l_{pl} \equiv r_q$) and time ($t_{pl} \equiv t_p$) are calculated in the Table, it is evident that their relation to the Whole is the same, that is:

$$m_{pl}/M_u = l_{pl}/R_u = t_{pl}/T_u = 2^{-cy/4-p/4} * (2\pi)^{-3/4} = 1.25126390816 * 10^{-61} \quad (40)$$

Therefore, the above equations are supporting the use of the assumed formula (13).

The formula (41), that is especially significant, is the one for the neutron exponent ne .

$$ne = p - q / (1 + \alpha'^2 \log_2 \mu) = 265.808779550 \quad (41)$$

From there we can easily obtain the neutron mass using the formula (4) and the result can be seen in the Table. It has been obtained through the induction method, starting from the idea that if many significant physical quantities in relation to the others contain the fine-structure constant, then it can be expected that the same is true for the neutron. In so doing, all the principles, approaches and methods shown in [9] were used. Occam's razor [10] played a special role in selecting the simplest solution. The formula is expected to be proven or rebutted through other methods.

It can be seen that it is enough to know μ and α' to determine the neutron mass. One of the modifications of the formula was given in (28), where simple relations among key parameters of the Universe can be detected more easily.

$$\alpha' = \sqrt{\frac{q/(p - ne) - 1}{el - p}} = 137.035999073 \quad (42)$$

The applied methodology leads to simple relations of the Whole and its parts, i.e. of the key parameters (here is $\hbar=h/2\pi$), for example:

$$\begin{aligned}
 m_p M_u m_{cy} m_f^{-3} (2\pi)^{-3} = 1 & \quad m_{pl}^4 m_p m_{cy} m_f^{-6} (2\pi)^{-3} = 1 & \quad (h * R_u)^{-4} 2\pi M_u G^2 m_p^5 \lambda_p^6 2^{cy} = 1 \\
 M_u^{1/3} m_{pl}^{-1/3} r_f^{-1} l_{pl} = 1 & \quad M_u m_{pl}^{-4} m_f^3 = 1 & \quad 2\pi h R_u^{-4} M_u G^2 c^{-5} \lambda_p 2^{cy} = 1 \\
 M_u m_f^{-3} m_q^2 = 1 & \quad R_u^2 G^2 m_f^6 \hbar^{-4} = 1 &
 \end{aligned}$$

These expressions are simple, just as is expected for the functioning of nature itself. Many attempts with similar formulas can be found in [11], [12], [13]. In [14, formula 21], it should be: $R_u^2 * G^2 * m_f^6 / \hbar^4 = 1$.

The advantage of using the Table is that knowing one parameter automatically gives values of the others at the same level. If we know the generalized radius, we automatically know the opposite radius, mass, wavelength and frequency. Therefore, the Table at level q , which includes Planck's length, has mass m_q (*hypothetical mass quantum*), see [6, p7] and [15, p5]. The same mass is also mentioned in the literature as the minimum mass (in my works, the envisioned minimum mass is at the cy level). At the q level, time is also 2π times larger than the Time Cycle, which leads to conclusion that the real mass is not possible there, hence at that level the *hypothetical mass quantum* is defined).

Furthermore, we obtain the formula for the proton charge radius, pcr :

$$pcr = 2\pi * r_{er} * m_{er} / m_p = 2\pi * r_{er}^3 / r_p^2 = 8.763902109 * 10^{-16} m \quad (43)$$

CODATA value is $8.775(49) * 10^{-16}$ [1].

The Table can also be used in the framework of one property, i.e. in one column. Hence, for example, Planck's mass is:

$$m_{pl} = \sqrt{M_u * m_q} \quad (44)$$

Namely, Planck's mass is the geometric mean of the mass of the Universe and hypothetical mass quantum.

Isto tako je na polovini Ciklusa geometrijska sredina mase univerzuma i matematičke zamišljene minimalne mase, formula (45):

Similarly, mass at Half Cycle is geometric mean of the mass of the Universe and envisioned mathematical minimal mass, formula (45):

$$m_z = \sqrt{M_u * m_{cy}} \quad (45)$$

Antonio Alfonso-Faus dedicated one whole paragraph in [16] to the importance of geometric mean.

Formule za Plankovu temperaturu (46) i temperaturu pozadinskog mikrotalasnog zračenja (47), koristeći (10) daje se ovde bez posebnog obrazloženja vidi [7, formula 1]:

$$T_{pl} = c^2 * m_p * k_B^{-1} * 2^{z/4-3/2+3/(4\theta+8)} * (2\pi)^{-3/4} = 1.4168337 * 10^{32} K \quad (46)$$

$$T_{BG} = T_{pl} / \sqrt[4]{2\pi * q^2 * 2^q / 9} = 2.725717 K \quad (47)$$

Where k_b is Boltzmann constant. Formula (47), with replacements, can be expressed in the form (48):

$$T_{BG} = c^2 m_p k_B^{-1} / (2\pi * 2^{(q-z-3/(\theta+2))/4} * \sqrt{8q/3}) \quad (48)$$

From (48) we can see that T_{BG} can also be expressed with fundamental physical and mathematical constants, but we can also see that the formula is much more complex. That is, of course, a general rule:

The higher the order of structures, the more complex the formulas expressed only through fundamental physical constants.

It is important to note that it is possible to express the relations between higher structures through fundamental physical constants.

In the Table, between the levels of the Universe and Planck's time n (θ , tp), there are complex structures such as galaxies, stars, planets, etc. Elementary particles are largely grouped around the Half Cycle, but they can probably be found in the entire domain n (g , q). In the domain n (e , cy) are structures that are considered massless, but which can still be assigned according to the model in the Table, however, here they are not being specifically examined. This article is limited to the structures in the domain n [θ , $e^{2\pi}$], although structures which encompass the domain n [θ , $e^{4\pi}$] are possible, and probably also n [θ , $e^{6\pi}$]. The understanding of structures and processes present in all the mentioned domains would enable a better understanding of the phenomena such as life, reason, spiritual world, etc.

6. Theoretical Bases and Confirmations of Calculations

This article is the expansion of the one published in the 2015 FQXi essay contest on the topic "*Trick or Truth: the Mysterious Connection between Physics and Mathematics*" [17].

I am influenced by numerous thinkers, but I do not have enough room to quote them all.

All I would say has already been told countless times and all my attempts at philosophy would thus be a repetition of what had already been stated. All the formulas shown are simple and derived from a logical starting point that:

Parts are dependent on the whole (Universe) and are also an integral part of the whole, therefore, the whole is also dependent on the parts!

That statement falls under one of the interpretations of Mach's principle [18].

Here it is also valid that:

The quantum character of phenomena is connected to the relations between the whole and its parts.

The above statement was implemented through the introduction of the mathematical constant, Cycle (8).

We applied the unity of opposites [19] philosophical principle, which is largely neglected in physics. The concept of opposites has a significant role in this article in multiple ways. It is exceptionally useful in the Table and it is at the same time confirmed there. To support the interpretation of singularity in physics, I will share the statement of Stevan Bošnjak [5], from the paragraph entitled The Postulate about the Opposites:

- *The Postulate about the Opposites states:*

The product of the opposites is a constant.

From The Postulate about the Opposites comes the conclusion that if there is singularity then there is also an infinitely large cosmos. Singularity would be the product of infinitely small (or zero) space and infinitely strong force, while the cosmos would be the product of infinitely large space and infinitely small (zero) force, i.e. they would form the opposite equality:

zero space \times infinitely strong force = infinite space \times zero force

Since the gravitational force is not infinitely small, hence cosmos is not infinitely spacious, and since not even the strong atomic force is not infinitely strong, there is no infinitely small space, i.e. singularity. Both the concepts (singularity and infinitely large cosmos) are just theoretical concepts, as physically they do have their boundaries.

The above mentioned statements are clearly confirmed in the Table. Let's state here several more opposites which can clearly be seen in the Table:

Product of time and frequency

$$t * \nu = t * 1/t = 1$$

Product of gravitational radius and Compton wavelength $Gm/c^2 * h/mc = Gh/c^3 = 2\pi * l_{pl}^2$

The spreadsheet of physical constants per publishing years of CODATA reports shows that the use of the proposed concept would give significantly more accurate values than those obtained via the CODATA methods. All the published and non-published formulas (those that did not fit the Table) have the same source. This means that the bit (information), Time Cycle, each specific cycle and relations among them, as well as relations among physical constants are immanent, and hence we have such accurate results for the values of physical constants in the Table.

The article shows the unsustainability of the term "coincidence" in relation to the large numbers of orders of magnitude 10^{40} , 10^{61} and 10^{122} . These numbers are not a coincidence and they appear as dimensionless relations that characterize relationships in nature. The role of the proton is crucial, since the constant β is derived from the relations relating to the proton and electron. We can accept the attitude that one relation providing a result with 12 correct significant digits is a coincidence, but we cannot accept that dozens of such results are coincidences. The presented formulas and the Table show a large number of physical constants that absolutely match CODATA values or data from the literature. Hence, we can claim that:

This concept is proven by the quantity of its applications.

The fine-structure constant can be presented in a wide range of occurrences and I expect many new occurrences to be discovered. It is certain that that constant deserves a more general definition than the current one, related only to the electrical charge.

I am certain that I am not the only one who has had these thoughts and conclusions; however, I have never come across a mathematical support to them such as the one I provided here, even though numerous well-known and unknown authors described the Universe in the manner compliant with mine.

The viewpoint closest to mine can be found in *Relational theory* [20], which states:

*"In physics and philosophy, a **relational theory** is a framework to understand reality or a physical system in such a way that the positions and other properties of objects are only meaningful relative to other objects. In a relational spacetime theory, space does not exist unless there are objects in it; nor does time exist without events. The relational view proposes that space is contained in objects and that an object represents within itself relationships to other objects. Space can be defined through the relations among the objects that it contains considering their variations through time.*

The relational point of view was advocated by in physics by [Gottfried Wilhelm Leibniz](#), [Ernst Mach](#) (in his [Mach's principle](#)), and it was rejected by [Isaac Newton](#) in his successful description of [classical physics](#). Although [Albert Einstein](#) was impressed by Mach's principle, he did not fully incorporate it into his [general theory of relativity](#)."

7. Conclusion

We used two known physical constants: the inverse fine-structure constant α^{-1} and the proton-to-electron mass ratio μ in order to interconnect a large number of physical values and phenomena through the **Table**. *Hypothesis 1* about the importance of mathematical constant in formula (8), *Hypothesis 2* expressed through formula (13) and the use of philosophical concept of the opposites, helped make the Table a tool for predictions of physical constants. The great accuracy of obtained values is shown in comparison with the CODATA (2010) values. A large number of presented formulas and their derivation can seem complicated and tiresome to the reader. However, everything becomes much more simple when the reader adopts the approach through the Table, via which those same formulas are obtained in a much more easy, simple and natural way.

The way in which the reality is comprised of elementary structures has been shown in the Table to a certain degree. The physical quantities which have not been included can be determined by the insertion of new rows and the search of relations that they have in the Table. On request, I can provide the original spreadsheet Table that enables the relevant calculations.

The problem of the number of dimensions has not been expressed, and there is no need for it, rather, the matter has been characterized through the mass, radius and time. The value of the radius of the Universe should not be regarded as the radius of the sphere; rather, it is the length which would be traveled at the speed of light over the course of the Time Cycle. It is apparent that this approach has not been hampered by all the mentioned simplifications. On the contrary, the simplifications have led to more accurate results. The method presented in the Table can further produce new accurate values, with consistent application of Occam's razor [10]. Of course, the knowledge about properties of a physical quantity whose relations are being determined can only help. Therefore, it is possible to obtain new constants as well, which could have further multiple applications.

The matching of obtained values of physical quantities with experimentally determined values confirms the correctness of the usage of the Cycle mathematical constant, $e^{2\pi}$. In the methodology presented, processes among structures take place in the domain of the Cycle $n [0, e^{2\pi}]$ and can in no way be reduced to a point. Hence, we can conclude that in physics singularity is also not possible. Singularity as the beginning and the destiny of the Universe is promoted in some theories, although singularity is an undefined state in mathematics and certainly in physics as well.

The presented concept does not produce paradoxes and absurd conclusions, which are too numerous in contemporary scientific literature. The Cycle and Time Cycle immanently and permanently produce relations and movements in material world.

There is a large number of superfluous terms in contemporary science, which serve to justify a "Theory". Hence, for example, the terms "matter dominant Universe" and "radiation dominant Universe" are proven in the Table to be unnecessary. The Table clearly shows that matter and radiation coexist in the domain $n [0, cy]$ and that there is no absurd transition in the development of the Universe. The only possible thing is that in different parts of the Universe one or the other type of organization of matter is dominant. In the Table, these two integral parts of the Universe

are divided in the framework of the Cycle: matter dominant Universe in the domain $n(0, z)$ and radiation dominant Universe in the domain $n(z, cy)$, hence that is the only way for dominance of one over the other.

Mass and radiation are opposites, so if one of them would be dominant, the constancy of the product of the opposite would be lost, which is contrary to the very definition of the opposite and formula (26).

In our material world, we understand the time in the fifth column from the shortest time needed to travel the proton Compton wavelength at the speed of light to the longest time needed for the photon to travel the radius of the Universe at the speed of light.

The formulas have been derived with the use of only seven basic mathematical operations. They are not inventions and should be the same for the aliens. Mathematical constants 2π , e , $\exp(2\pi)$ have been used to a great extent. The approach is rational, encompassing mathematical constants and relations among physical constants in the statement:

The whole and its parts are immanently dependent on each other.

Relationships between physical constants are essential and every particular phenomenon is a consequence of those relationships.

Based on the Table we can conclude that:

- It is in accordance with Mach's principle, i.e. "The whole and its parts are immanently dependent on each other";
- It shows the essence of the Planck values;
- The story about the number of dimensions is irrelevant;
- The connection between physics and mathematics is essential;
- It can help us determine relationships between other physical values.

Appendix.

Relation (13) is because:

- the proton is considered the originator of matter creation in a narrower sense (substance);
- results obtained are considerably poorer if the value of Δp is changed by a small amount;
- "1" and "2" in the formula we can maybe call the first and second level of organization of extended matter from non-extended matter;
- Just like some other universally accepted formulas, it is justified by the large number of its confirmations;
- It can be shown that standard deviation in the determination of the inverse fine-structure constant by using different formulas is the smallest when (13) is used.
- Let's find the relation which contains Δp and physical constants which are well known, hence their relationship can be checked. In the Table, in which all the non-dimensional and

dimensional physical constants appear in a larger number of relationships, the same applies to Δp . Hence, (49) is also true, presented with the accuracy related to Planck's mass.

$$\Delta p = cy / 6 - \log_2(2\pi) - 4\log_2(m_{pl} / m_p) / 3 = 1.935061 \quad (49)$$

This formula is obtained from the Table in which:

$$(m_{pl} / m_p) = M_u 2^{-g} / M_u 2^{-p} = 2^{f-g} / 2^{f-p} = 2^{q/6} / (2\pi * 2^{2\Delta p/3}) \quad (50)$$

And since:

$$q = 3cy/4 + 3\log_2(2\pi)/2 - \Delta p/2 \quad (51)$$

It follows that:

$$(m_{pl} / m_p) = 2^{cy/8 - 3\Delta p/4} * (2\pi)^{-3/4} \quad (52)$$

Odakle logaritmovanjem za osnovu dva i sređivanjem dobijamo (49).

From which we obtain (49) by applying logarithms for the base two and sorting it out.

Similarly, we obtain formula Δp from the proton Compton wavelength and Planck length, which I am sharing here without derivation:

$$\Delta p = cy / 6 + \log_2(2\pi) / 3 - 4\log_2(\lambda_p / l_{pl}) / 3 = 1.935061 \quad (53)$$

In (53) the result is given with seven significant digits, as much as the currently known value of the Planck length has, although in the Table we can see the more accurate value, $\Delta p = 1.93506094352$.

Formulas (49) and (53) can be used instead of (13), where the results have the accuracy of the Planck values which are less reliable than the values used in (13). I believe that it is better that we keep (13), even though the formula has not been derived, while its precise elaboration can lead to new significant conclusions.

Further progress in the examination of validity of formula (13) is possible if the Table is filled in by using software that allows more than 15 significant digits, the current limit in the spreadsheet software.

Novi Sad, December 2016

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