A New Large Number Numerical Coincidences

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Abstract.
In this article the author gives a bunch of new hypothesis and presents new exact and simple relations between physical constant and numbers. The author briefly analyzes the discovered coincidences in terms of their accuracy and confidence but he leaves aside any physical explanation of the presented formulas. However all shown relations experience common nature of "power of two". As exact nature of this is unknown yet so it requires further investigation. Presented material may also be viewed as logical continuation and development of Dirac's-Eddington Large Numbers hypothesis (LNH). However opposite to Dirac's LNH two of presented ratios are not approximate but they have exact equality. This allows theoretical prediction of the Universe radius as well as calculation of exact value of the gravitational constant G which all fall within the range of current measurements data and existing precision. Author formulates these Large Number Numerical (LNN) coincidences realizing that further discovery of their meaning may lead to significant change in our understanding of the Nature.

Notations: In this work, SI units are used.

The attempts of bringing together physics and numerology had been done before many times but very important step was done in 1938 by Arthur Eddington. According to Arthur Eddington proposal the number of proton in entire Universe should equal exactly to: $N_{Edd}= 136* 2^{256} \sim 10^{80}$ [1,2]. So, therefore square root of N_{Edd} should be close to Dirac's Big number $N\sim\sqrt{136 * 2^{256}} = \sqrt{136} * 2^{128}$. Later on, Eddington changed 136 to 137 and insisted that the fine structure constant has to be precisely 1/137, and then his theory seemed to fail at this cornerstone. However, Eddington statement also had the number $(2^{128})^{2}$ which was left without proper attention. Actually few years earlier, in 1929, it was German physicist R. Fürth who proposed to use 16^{32} (which is also 2^{128}) in order to connect gravitation to atomic constants [10]. However, all these coincidences have been left unexplained until present time. As it was said by G. Gamov [16]: "Since the works of Sir Arthur Eddington, it has become customary to discuss from time to time the numerical relations between various fundamental constants of nature". For example, another interesting attempt to use "a log-base-2 relation" between electromagnetic and gravitational coupling constant was made by Saul-Paul Sirag, the researcher from San Francisco in 1979 [12]. Particularly power of 2, according to the author's idea, should have significant role in numerical relations for the physics constants.

Suggested four Large Number Numerical (LNN) relations or coincidences are presented below. These coincidences are not dependent and related to each other, so prove or disprove of one of them does not mean the same for the others. They all have common number of 2^{128}. First two relations pretend to be exact equations, and second two are valid with defined uncertainty. Because of that second two relations are also called 'weak'.

1. Cosmological coincidence.

The relation is analog of famous Dirac's ratio $R_U/r_e\sim 10^{40}$ which connects radius of the Universe and classical electron radius. However Dirac's ratio is actually valid only approximately (with precision of "the same order of magnitude"), in opposite, the suggested replacement is exact equation as following:

$$\frac{R_U}{\lambda_e} = 2^{128} \qquad (1)$$

Where R_U is value for the radius of the observable Universe and $\lambda_e = \hbar/(m_e c)$=3.86..*$10^{-13}$(m) is electron's reduced Compton wavelength (De Broglie wave). The relation (1) provides us with precise size and age of the observable Universe. So it leads to exact value for the Universe radius of R_U=1.314031*10^{26} meters corresponding to the Universe age of 13.8896 billion years.

Recently F.M.Sanchez, V.Kotov, C.Bizouard discovered that the use of the reduced electron Compton wavelength is decisive for the compatibility of the Hubble-Lemaitre length with 2^{128} [13-15]. They use this

length unit because of proposed holographic relation involving it. Here the author independently developed this idea suggesting that (1) is exact relation.

The measured age of the Universe, according to the Wilkinson Microwave Anisotropy Probe (WMAP) 7-year results, is 13.75 ± 0.13 billion years [9]. Latest NASA observation by Hubble gives the age of the Universe as 13.7 billion years [3]. It is very close to the obtained value and lies in the existing error range. So, the coincidence (1) pretends to define the exact Universe elapsed life time as:

$$T_U = \lambda_e / c * 2^{128} \quad (1.1)$$

Important to note, that having (1.1), initial Dirac's relation may be expressed in the following form:

$$N_1 = \frac{R_U}{r_e} = \alpha^{-1} * 2^{128} \quad (1.2)$$

where α^{-1}=137.036.. is inverted fine structure constant and $r_e = ke^2/m_e c^2$ – classical electron radius with eliminated numerical factor (i.e. equal to unity) and N_1 is exact value for the large number introduced by Dirac ($4.66*10^{40}$). As we know for sure that Universe is expanding $R_U(t)$, so the equation (1) suggest that one or few of the fundamental constants (ħ, c, m_e) should also vary in time.

However, current uncertainty in R_U measurement still leaves a room for another alternative ideas and possible coincidences. For example, noting that $m_p/m_e \sim {}^{40}/_3 \alpha^{-1}$, relation (1) can have another form:

$$R_U = \frac{m_p}{m_e}\frac{1}{4}\left(\frac{3}{10}\frac{ke^2}{m_e c^2}\right)2^{128} \quad (1.3)$$

which would correspond to 13.95809 Gyr. As this value is currently out of the present WMAP data frame, therefore it is not supported by the author here.

2. Electron-proton Radius Coincidence.

Another interesting idea connects the classical proton radius and gravitational radius of the electron by exact equation as following:

$$\frac{r_p}{r_{ge}} = 2^{128} \qquad (2)$$

where $r_p = ({}^1/_2)({}^3/_5)\, ke^2/(m_p c^2)$ - classical proton radius an $r_p = 2Gm_e/c^2$ – gravitational electron radius (i.e. the Schwarzschild radius for the electron mass). Of course some comments are required regarding coefficients (${}^1/_2$) and (${}^3/_5$). Usually numerical factors are ignored and assumed to be unity when defining classical (electron) radius. However suggested new definition has exact numerical factor (${}^3/_{10}$)= (${}^3/_5$)*(${}^1/_2$), so it is obvious to have following explanations for that one by one:

* Ratio ${}^3/_5$ in classical proton radius definition.

The only important difference with modern representation of classical radius is the coefficient ${}^3/_5$. It is well known from the electrostatics that the energy required to assemble a sphere of constant charge density of the radius r and charge r is E= (${}^3/_5$) ke^2/r. Usually factors of ${}^3/_5$ and ${}^1/_2$ are ignored while defining classical electron radius. Surprisingly the coincidence advices the use of ${}^3/_5$ which means that charge is equally spread within the sphere of the electron or proton radius.

* Ratio ${}^1/_2$ in classical proton radius definition.

Usual definition of the classical radius does not require having ½ because initially one relates total electrostatic energy (E_e) of the electron (or proton) to rest mass energy as following: $E_e = mc^2$. Factor ½ appears if we postulate that electromagnetic energy (E_{em} of the electron or proton) is just a half of particle's rest mass energy: $E_{em} = ½\, mc^2$. There are two possible alternative explanations for the ½ factor:

1) The Virial Theorem that tells us that the potential energy inside a given volume is balanced by the kinetic energy of matter and equals to half of it. So if one considers electromagnetic energy as kinetic and rest mass as potential energy we would have: $E_{em} = ½\, mc^2$

2) Simply assuming that half of total energy may be a magnetic energy or of another nature.

One may also propose that there could be no ½ in classical proton radius definition, but there is 2^{129} instead of is 2^{128} in formula (2). From the author's point of view this does not correspond to reality and

particularly the number 2^{128} should have strong and unchangeable power in all numerical expressions of the Nature.

It is easy can be seen that $r_p = (m_e/m_p)\, r_e$, so another way to rewrite (2) is:

$$\frac{r_e}{r_{ge}} = \frac{m_p}{m_e} 2^{128} \qquad (2.1)$$

And this leads to another possible representation of the initial formula as:

$$\frac{r_e}{r_{gp}} = 2^{128} \qquad (2.2)$$

where r_e- is classical electron radius, r_{gp} – is gravitational radius of the proton. The expression (2.2) is very similar to (2). So, we may actually combine them into another interesting equation:

$$r_p r_{gp} = r_e r_{ge} \qquad (2.2a)$$

The precision of the Electron-proton coincidence given by (2) is 0.02%. From the author's point of view this deviation originates from current uncertainty in gravitational constant (G) measurement. If we consider that the relative G uncertainty nowadays is around and not less than 0.02% than we must accept this amazing and unexplained coincidence that allows us to predict exact value for the gravitational constant (G). So, this founding suggests that at least following possible consequences are valid:

1) Because of $^3/_5$ ratio proton or electron still may be considered as *classical* particle with uniform charge density inside its radius.

2) Directly from (2) one can express the value of Newtonian constant of gravitation (G) which exactly follows as:

$$G = \frac{3ke^2}{20 m_p m_e} 2^{-128} \qquad (2.3)$$

It leads to exact value for G = 6.674 632* 10^{-11}. This value is within the frame of 2010 CODATA-recommended value with standard uncertainty given by: 6.67384±0.00080* 10^{-11} [6] (See also figure).

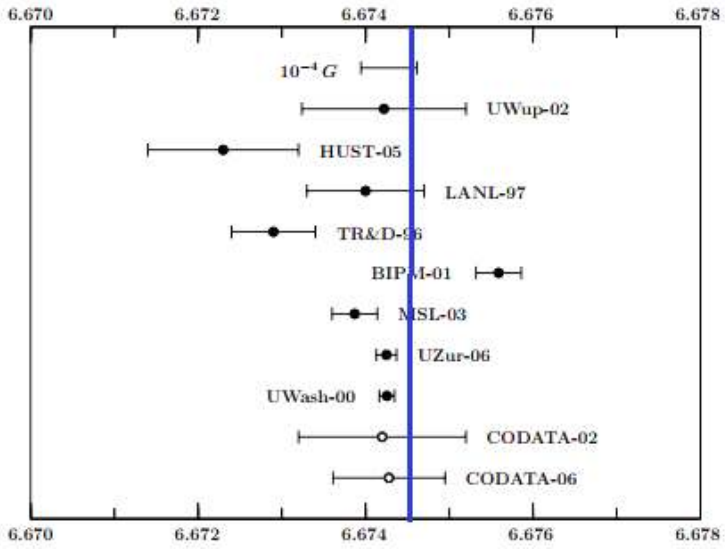
One may compare this expression with the similar one obtained in 1929 by R. Fürth [10]:

$$\frac{hc}{\pi (m_p + m_e)^2 G} = 16^{32}$$

that is read in SI units for G as:

$$G = \frac{\hbar c}{(m_p + m_e)^2} 16^{-32}$$

It is interesting to compare it to (2.3) to note obvious similarity. However, one may see that the expression is not satisfactory because it would lead to greater deviation (0.59%) from the currently established value for G and would be out of 2010 CODATA range (6.63466* 10^{-11}).



3) It is easy to note that Dirac's Large Number N precisely equals to:

$$N = \frac{ke^2}{Gm_p m_e} = \frac{20}{3}2^{128} \quad (2.4)$$

This means that variation of Dirac's Large Number (N) in time is hardly possible, because 2^{128} represents simply the constant number. So the ratio of the electromagnetic force to the gravitational one remains always constant during the current epoch.

3. Weak cosmological coincidence.

$$\frac{2c^3}{G} \cong \frac{m_p}{t_p}2^{128} \quad (3)$$

Where c- is speed of light, G – is the gravitational constant, $t_p=\hbar/(m_p c^2)$– period of reduced Compton wave of the proton. This equation may be interpreted as relation of rate of mass growth or the expansion rate of the Universe [4, 5] to harmonic properties of the proton as wave. However the relative precision of (3) is 0.48% (or even 0.49% if we accept definition of G as in 2.3) which is unsatisfactory for modern measurements and it makes the expression valid only approximately. In order to become more precise the expression should have a following representation:

$$\frac{2c^3}{G} \cong \frac{m_p + 9m_e}{t_p}2^{128} \quad (3.1)$$

Or alternatively to become exactly precise:

$$\frac{c^3}{G} = \frac{m_e}{t_p}\frac{20}{3}\alpha^{-1}2^{128} \quad (3.2)$$

But further discussion of this topic will be explored more detailed in further author's works.

4. Weak Electron-proton mass ratio.

The attempts to explain large numbers by placing inverted fine structure constant in exponential function were done many times before [11,12]. Another interesting hypothesis could relate proton to electron ratio with fine structure constant and the number 2^{128} in the following manner:

$$\frac{m_p}{m_e} \cong \frac{7}{2}2^{137.036..-128} \quad (4)$$

However the relative precision is still comparably high (0.06%) and is out of the error frame within the current experimental data. However, using this relation as approximation, one can find similar connections of derived formulas to the similar ones in work [12].

Conclusion.

The basic meaning of all these relations may be viewed in the form of exact equality for large Dirac's number N (see 2.4). However all these proposals disprove one of Dirac's hypothesis of the equality of the big numbers [see 2, page 100]. So, the author has shown that $N \neq N_1 \neq \sqrt{N_{Edd}}$. It means that the number N, as the ratio of the electromagnetic force to its gravitational force given by (2.4), is actually not equal to number N_1 which is the ratio of Universe radius to classical electron radius (1.2), however they differ by numerical factor of $20.55=\alpha^{-1}*3/20$.

So, the main collusions of this study are following:

- Current Universe age and radius can be calculated exactly (13.8896 Gyr);
- The value of Newtonian constant of gravitation (G) can be derived exactly ($6.674632*10^{-11}$);
- The number 2^{128} should have the real significance.

Generally the concept of «power of two» could be regarded as having two properties in the science. Firstly it is digital (logical) math where power of two has common use. So this may support an idea of holographic concept of the Universe or some of the fractal theories. Secondly, it is used in wave mechanics, and it could be viewed in accordance with wave properties of the elementary particles in quantum physics. In terms of wave concept, the number of 2^{128} corresponds to the tone of 128-th octave or to some higher harmonic ("overtone") of the main tone. Interestingly to mention, that a very close idea has been brought few ears ago. The idea relates particles mass levels within two sequences that descend in geometric progression from the Planck Mass. Sublevels are arranged in subsequences of common ratio which uses a power of 2 [7,8]. The author is also very supportive to the point of view given in [13-15], however it is important to stress that the physics should be free from approximate relations and should have only precise equalities and formulas. Some of the exact formulas which may help to support such general ideas have been presented in this work.

If new suggested relations for Large Numbers are correct then it should probably lead to new search for its hidden meaning. As always, we must accept the fact that in often cases new founding leads to new questions instead of the answers and that might become a new challenge for new investigations and theories. Assuming that at least one of the discovered relations is correct in the future we may become a bit closer to the true view on the physical reality.

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