Physical Science International Journal

15(3): 1-19, 2017; Article no.PSIJ.34613
ISSN: 2348-0130

On a Plausible Triple Electro-gravito-informational Significance of the Fine Structure Constant

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/PSIJ/2017/34613
Editor(s):
(1) Aleksey Anatolievich Zakharenko, The International Institute of Zakharenko Waves (IIZWs), Krasnoyarsk, Siberia, Russia.
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Complete Peer review History: http://www.sciencedomain.org/review-history/20204

Short Research Article

Received 1st June 2017
Accepted 18th July 2017
Published 27th July 2017

ABSTRACT

In the last century, a small minority of physicists considered a hypothetical binary logarithmic connection between the large and the small constants of physics, which also implies a base-2 power law (Fürth, 1929; Eddington, 1938; Teller, 1948; Salam, 1970; Bastin, 1971; Sirag, 1980, 1983; Sanchez, Kotov and Bizouard, 2009, 2011, 2012; Kritov, 2013). This paper brings to attention a plausible triple electro-gravito-informational significance of the fine structure constant, with its implications in a plausible four fields unification pattern at Planck scales: this triple significance is based on the existence of a unifying global scaling factor of nature which appears in a hypothetical fine tuning of all the non-zero rest masses of the all the elementary particles in the Standard Model. Furthermore, this paper also proposes the dimensional relativity hypothesis (DRH) stating that the 3D appearance of space (or the 4D nature of spacetime) may be actually explained by the relative magnitude of the photon (angular) quantum momentum (and the hypothetical graviton quantum momentum respectively) and this global scaling factor (GSF): DRH also includes a generalized electrograviton model (EGM) for any hypothetical graviton. This paper also proposes a set of strong (and very strong) gravity constants and a gravitational field varying with the energy (and length) scale, all with potential importance in the unification of the four fundamental fields. Each of these hypotheses is a potential update for the Standard Model of particle physics.

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Keywords: Fine structure constant with triple electro-gravito-informational significance; unifying global scaling factor of nature; four fields unification; the standard model of particle physics; dimensional relativity hypothesis; electrograviton model.

1. INTRODUCTION [1]

In 1929, the German physicist R. Fürth proposed the adimensional constant $16^{32} = 2^{128}$ as a possible "connector" between gravitational and quantum mechanics constants [2].

Arthur Eddington (1937) and Dirac (1937) have remarked the coincidence of the large adimensional numbers in physics which can be reformulated as: $a / a_{Gv} \cong R_H / r_e \cong N^{1/2} \cong 10^{40}$ ($a = 1/\alpha \cong 137$ is the inverse of the fine structure constant [FSC] at rest $\alpha = k_e q_e^{\,2} / (\hbar c) \cong 1/137$; $a_{Gv} = 1/\alpha_{Gv} \cong 3.1 \times 10^{41}$ is the inverse of a variant of the gravitational coupling constant [GCC] $\alpha_{Gv} = (Gm_p m_e / c)/\hbar \cong 1/(3.1 \times 10^{41})$; $R_H = c / H_0 \cong 14.5 \times 10^9 \, light-years$ is the Hubble radius of the observable universe, which is a function of the Hubble constant $H_0 \cong 71.9[(km/s)/Mpc]$; $r_e = k_e q_e^{\,2} / (m_e c^2) \cong 2.8 \times 10^{-15} m$ is the classical radius of the electron at rest; $N \cong 10^{80}$ is the approximate number of nucleons in our observable universe, a number which can be estimated by astrophysical methods).

In 1938, Arthur Eddington proposed that the number of protons in the entire Universe should be exactly equal to: $N = 136 \times 2^{256} \cong 1.57 \times 10^{79}$ (N was later called the Eddington's number N_{Edd}) and Eddington hypothesized that square root of N_{Edd} should be close to Dirac's big number (which he invoked in his large number hypothesis) such as $\sqrt{N_{Edd}} = \sqrt{136 \times 2^{256}} = \sqrt{136} \times 2^{128} \cong 3.97 \times 10^{39}$. Later on, Eddington changed 136 to 137 (using the new experimental values of α [re]determined in his life time) and (re)insisted that α had to be precisely $1/137$, a fact which attracted irony at that time [3]. However, Eddington's statement also implied the adimensional constant 2^{128}, which wasn't given proper attention for the next 10 years (Kritov [4]).

In 1948, Edward Teller proposed a possible logarithmic connection between α and $Gm_N^{\,2} / (hc) \cong 10^{39}$ of the form $\alpha^{-1} \cong \ln\left[Gm_N^{\,2} / (hc)\right]$, with m_N being the standard rest mass of a nucleon (proton or neutron) [5].

In 1970, Abdul Salam also brought in attention a possible logarithmic connection between α_{Gv} and α [6].

In 1971, Edward Bastin invoked the observation $a_{Gvv} = \hbar / (Gm_p^{\,2} / c) \cong 1.7 \times 10^{38} \overset{99\%}{\cong} 2^{127}$ and proposed the derivation of $a = 1/\alpha \cong 137$ from the exponent 127 by summing 127 with its series of digits, such as 127+(1+2+7)=137 [7].

In 1980, Saul-Paul Sirag also proposed an alternative interpretation of the binary logarithmic relation between $a = 1/\alpha$ and $a_{Gv} = 1/\alpha_{Gv}$, such as $\log_2(a_{Gv}) = 137.84 \overset{100.6\%}{\cong} a$. (Sirag [8]).

John D. Barrow and Frank Tipler probably didn't know about Salam's (1970), Bastin's (1971) and Sirag's (1980, 1983) works on this subject, when they wrote in 1986 that: „Edward Teller appears to have been the first who speculated that there may exist a logarithmic relation between the fine structure constant α and the parameter $Gm_N^{\,2} / (hc) \cong 10^{39}$ of the form $\alpha^{-1} \cong \ln\left[Gm_N^{\,2} / (hc)\right]$ [equation 4.23] (in fact $\alpha^{-1} \cong \ln(3.27 \times 10^{59})$ [corrected estimation] and the formula is too insensitive to be of very much use in predicting exact relations)" [9,10]. (m_N also stands for the nucleon [proton/neutron] rest mass).

Regrettably, Barrow and Tipler also ignored Eddington's works on the subject which could have inspired them to analyze the much more "sensitive" binary logarithm variant $\log_2\left[Gm_N^{\,2} / (hc)\right]$ instead of the natural logarithm variant $\ln\left[Gm_N^{\,2} / (hc)\right]$. This paper proposes additional arguments against Barrow and Tipler superficial analysis of this subject and continues the works of all the authors previously cited who "advocated" in the favor of this binary logarithm connection.

The recurrence of 2^{128} and $2^{a}\left(=2^{1/\alpha}\right)$ factors in these (probably just apparent) numerical coincidences suggests that base-2 power law may have a significant role in numerical relations of these physical constants, predicting the existence of a universal (large) scaling factor of nature (indissolubly related to the fine structure constant) with important implications in a possible fine-tuning of all non-zero rest masses of all known elementary particles in the standard model, with implications for the existence of life forms in our universe.

2. THE EXISTENCE OF UNIFYING GRAVITATIONAL SCALING FACTOR BASED ON A HYPOTHETICAL ELECTRO-GRAVITATIONAL SIGNIFICANCE OF THE FINE STRUCTURE CONSTANT

There is a high probability to exist a profound (direct and/or indirect) connection between the (very) large and the small adimensional constants (invariants or quasi-invariants) in physics. If there is a connective function between these two types of adimensional constants, the most plausible and natural candidate for this is a logarithmic function: also note that all the running coupling constants of all non-gravitational fundamental forces are logarithmic functions of the energy/length scales.

Let us consider a generalized gravitational coupling constant $\alpha_G\left(m_x, m_y\right)=G m_x m_y /(\hbar c)$ and its inverse $a_G\left(m_x, m_y\right)=1 / a_G\left(m_x, m_y\right)=\hbar c /\left(G m_x m_y\right)$ for any two identical or distinct non-zero rest masses m_x and m_y of any pair of elementary particles (**EPs**) in the standard model (**SM**). Let us consider a base-2 logarithmic function $f\left(m_x, m_y\right)$ which compares $a_G\left(m_x, m_y\right)$ with the inverse of the fine structure constant (**FSC**) $a=1 / \alpha=\hbar c /\left(k_e q_e{}^2\right) \cong 137$ such as:

$$f\left(m_x, m_y\right)=\log_2\left[a_G\left(m_x, m_y\right)\right] / a \qquad (2\text{-}1)$$

Interestingly, the function $f\left(m_x, m_y\right)$ has its values relatively close to 1, in the double closed interval $[0.817,\, 1.085]$ with an arithmetic average of $\cong 0.93$ which is also respected on the "diagonal" values (as detailed in the Table 1 and Fig. 1: obviously, the values of $f\left(m_x, m_y\right)$ tend to be super-unitary for the combinations of the lightest EPs and sub-unitary for the rest of EPs.

As seen from the previous table and figure, the sub-unitary values seem to predominate, as the three leptonic flavors of neutrino (which are almost surely lighter than the electron) weren't yet graphed, given the difficulty in determining their exact non-zero rest masses.

The values of the function f are also plotted in a graph, sorted in ascending order, revealing a stair-like shape with a quasi-linear trend line: see the Fig. 2a.

The electron neutrino $\left(\nu_e{}^0\right)$ rest mass is estimated to be in the interval $[0.2,\, 2]\, eV / c^2$ [11]. For $m_{\nu_e} \overset{hyp.}{\cong} 1.85 eV / c^2$ (which is the last experimental estimation) and $m_y \in \left\{\begin{array}{l}\mathrm{m}_u,\, \mathrm{m}_d,\, \mathrm{m}_c,\, \mathrm{m}_s,\, \mathrm{m}_t,\, \mathrm{m}_b, \\ \mathrm{m}_e,\, \mathrm{m}_\mu,\, \mathrm{m}_\tau,\, \mathrm{m}_W,\, \mathrm{m}_Z,\, \mathrm{m}_H\end{array}\right\}$,

$$f\left(m_{\nu_e}, m_y\right) \overset{hyp.}{\in} \left\{\begin{array}{l}1.201,\, 1.193,\, 1.134, \\ 1.161,\, 1.083,\, 1.122, \\ \mathbf{1.217},\, 1.161,\, 1.131, \\ 1.091,\, 1.09,\, 1.086\end{array}\right\},$$ which extends the interval of values of f to $[0.817,\, 1.217]$ (by adding more super-unitary values to it and equilibrating the previous "mix" which was dominated by sub-unitary values): this last interval is approximately centered in value 1 and is relatively symmetrical and "equilibrated" around this value with two sub-unitary and super-unitary "wings" (1 ± 0.2); the arithmetic average of this extended interval of f values increased to $\cong 0.97$ and preserves the stair-like shape (with a quasi-linear trend line) when graphed values are graphed in ascending order: see the Fig. 2b.

Table 1. The values of the function $f\left(m_x, m_y\right) = \log_2\left[\hbar c / \left(G m_x m_y\right)\right] / a$ in the double closed interval $[0.817, 1.085]$

Elementary particles	Quarks*						Leptons**			Bosons***		
	$u^{+2/3}$	$d^{-1/3}$	$c^{+2/3}$	$s^{-1/3}$	$t^{+2/3}$	$b^{-1/3}$	e^{-}	μ^{-}	τ^{-}	$W^{+/-}$	Z^{0}	H^{0}
$u^{+2/3}$	***1.053***	*1.046*	0.987	*1.014*	0.935	0.974	*1.069*	*1.013*	0.983	0.943	0.942	0.938
$d^{-1/3}$	*1.046*	***1.038***	0.979	*1.006*	0.927	0.966	*1.061*	*1.005*	0.976	0.935	0.934	0.931
$c^{+2/3}$	0.987	0.979	**0.92**	0.947	0.868	0.908	*1.002*	0.946	0.917	0.877	0.875	0.872
$s^{-1/3}$	*1.014*	*1.006*	0.947	**0.974**	0.895	0.935	*1.029*	0.973	0.944	0.903	0.902	0.899
$t^{+2/3}$	0.935	0.927	0.868	0.895	**0.817**	0.856	0.951	0.895	0.865	0.825	0.824	0.82
$b^{-1/3}$	0.974	0.966	0.908	0.935	0.856	**0.895**	0.99	0.934	0.904	0.864	0.863	0.859
e^{-}	*1.069*	*1.061*	*1.002*	*1.029*	0.951	0.99	***1.085***	*1.029*	0.999	0.959	0.958	0.954
μ^{-}	*1.013*	*1.005*	0.946	0.973	0.895	0.934	1.029	**0.973**	0.943	0.903	0.902	0.898
τ^{-}	0.983	0.976	0.917	0.944	0.865	0.904	0.999	0.943	**0.913**	0.873	0.872	0.868
$W^{+/-}$	0.943	0.935	0.877	0.903	0.825	0.864	0.959	0.903	0.873	**0.833**	0.832	0.828
Z^{0}	0.942	0.934	0.875	0.902	0.824	0.863	0.958	0.902	0.872	0.832	**0.83**	0.827
H^{0}	0.938	0.931	0.872	0.899	0.82	0.859	0.954	0.898	0.868	0.828	0.827	**0.824**

Note: The super-unitary values (corresponding to the combinations between the lightest elementary particles) were marked in italics.

**only the average estimated rest mass of quarks was considered (without their individual rest mass determination uncertainties);*

*** only the leptons with known rest masses were tabled (such as the three leptonic flavors of neutrinos were excluded for the moment);*

**** only the bosons with non-zero rest masses were tabled;*

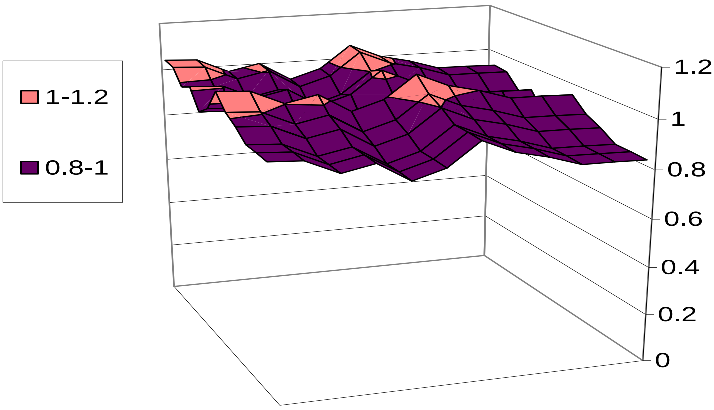

Fig. 1. The values of the function $f\left(m_x, m_y\right) = \log_2\left[\hbar c / \left(G m_x m_y\right)\right] / a$ in the double closed interval $[0.817, 1.085]$

$f\left(m_{\nu_e}, m_{\nu_e}\right) \overset{hyp.}{\cong} 1.349$ also adds to this interval (1 ± 0.2) as an apparently "isolated" value, but which pushes the arithmetic average of f values to $\cong 0.98$ and $\cong 1.01$ (for the diagonal values only) (values even closer to 1) and which may suggest the existence of EPs (with non-zero rest masses and probably zero-charged) even lighter than the neutrinos to fill the gap between 1.2 and 1.349 and even to extend this interval.

The most plausible candidates to fill that gap (at least partially) are the sterile neutrinos (neutrinos with right-handed chirality which are well-motivated theoretically, as all other known fermions have been observed with left and right chirality), in the case they shall be confirmed to have non-zero rest energies <1eV. Other plausible candidates are the lightest supersymmetric particles (hypothetical particles proposed by supersymmetric models), probably neutralino (which is the most plausible candidate for the main constituent of the hypothetical dark matter), the gravitino and the lightest sneutrino.

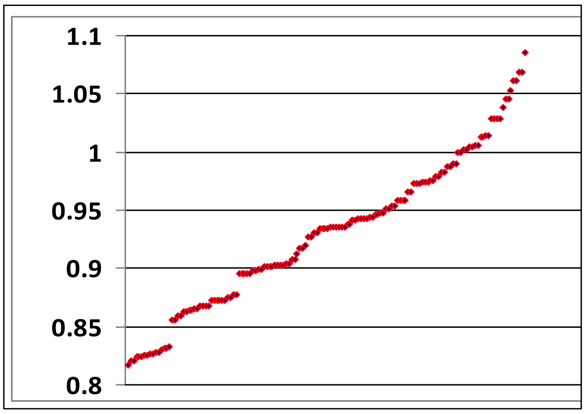

Fig. 2a. The values of the function f (without considering neutrino rest mass combinations) sorted in ascending order

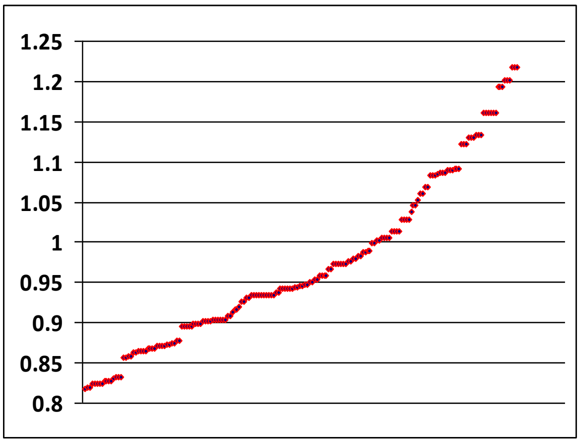

Fig. 2b. The values of the function f (also considering the combinations of the three neutrino rest masses of ~1eV/c^2) sorted in ascending order

Furthermore, even if the proton and the neutron aren't elementary particles, $f(m_p, m_y)$ and $f(m_n, m_y)$ also have values that "fit" in the same approximate interval 1 ± 0.2, as those nucleons have rest masses relatively close (with the same order of magnitude) to the tauon rest mass, for which $f(m_\tau, m_e)\cong 0.999$: $f(m_N, m_e)\cong 1.006$.

A special case (disserving a separate discussion) is $f(m_e, m_\tau)\cong 0.9991$, with $\log_2\left[\hbar c/\left(G m_e m_\tau\right)\right] \cong 136.914$, which is strikingly close to $a=\hbar c/\left(k_e q_e^{\,2}\right)\cong 137.036$. The mass "ambitus" defined by the double closed interval $\left[m_e, m_\tau\right]$ (with $m_\mu \in \left[m_e, m_\tau\right]$) has a special significance in particle physics, as it is defines the minimum and the maximum elementary masses that can be "stored" on a negative/positive elementary charge in the case of charged leptons/antileptons, accordingly to the Standard Model (**SM**). The closeness $\log_2\left[\hbar c/\left(G m_e m_\tau\right)\right] \overset{99.91\%}{\cong} \hbar c/\left(k_e q_e^{\,2}\right)$ suggests that the gravitational energy of an electron(/positron)-tauon(/antitauon) pair is centered (base-2) logarithmically with unexpected high accuracy around the electromagnetic dimensionless $a=\hbar c/\left(k_e q_e^{\,2}\right)$: this is an indirect proof that gravity may partially break the charge symmetry of the electromagnetic field and allow two or more distinct masses for the same charged EP, but preserving the base-2 logarithmic law defined by $f(m_x, m_y)\cong 1$ in relation to the electromagnetic field energy quanta $E_{ph}(\lambda)=\hbar c/\lambda$, so that $\hbar c/\left(G m_e m_\tau\right)\cong 2^{\hbar c/\left(k_e q_e^{2}\right)} \cong 2^a$ and $a\cong \log_2\left[\hbar c/\left(G m_e m_\tau\right)\right]$.

The secondary "diagonal" function $a_x=\log_2\left[\hbar c/\left(G m_x^{\,2}\right)\right]$, with $m_x \in \left\{\begin{matrix} m_u, m_d, m_c, m_s, m_t, m_b, m_\nu \\ m_e, m_\mu, m_\tau, m_W, m_Z, m_H \end{matrix}\right\}$ has values in the approximate interval $\left[110, 190\right]$ with two relatively symmetrical "halves" below and above $a=1/\alpha\cong 137$ and a stair-like graph shape, as represented in the Fig. 2c.

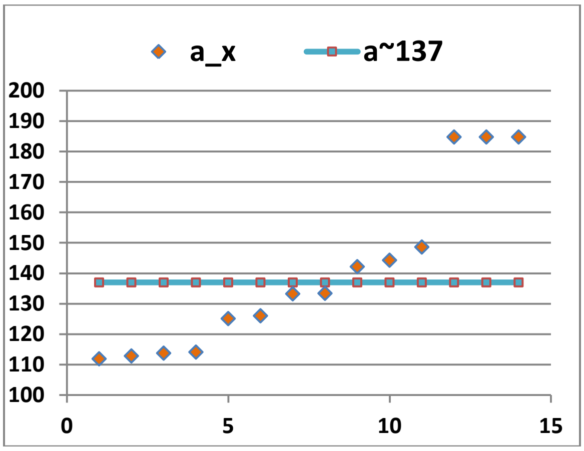

Fig. 2c. The values of the function a_x sorted in ascending order, also considering three neutrino rest masses of ~1eV/c^2

One may notice from the previous figure that all the step-10 subintervals of a_x values $[110,120]$, $[120,130]$, $[130,140]$, $[140,150]$ and $[180,190]$ is occupied by a stair-like group of four, three or at least two EPs with non-zero rest masses. The "gap" consisting of subintervals $[150,160]$, $[160,170]$ and $[170,180]$ may be also occupied by other light EP undiscovered yet, as already discussed previously.

This paper considers that it is very unlikely for the relatively large diversity of EPs non-zero rest masses to be strongly centered logarithmically around $a=1/\alpha\cong 137$ only due to a "simple" coincidence: by contrast, it is very plausible that the existence of this "unity in diversity" to be the consequence of a more profound law of nature, as α is also the expression of a charge-anticharge symmetry (which was verified to be exact with very high accuracy) with no clear and definitive explanation yet.

$f\left(m_x,m_y\right)$ may prove not only a fine tuning of all the elementary rest masses alone (by their combinational pair products), but more importantly and especially a fine tuning of big G magnitude, which has an essential role in significantly "assuring" the "centering" of the f values of around 1. The gravitational coupling function $\alpha_G\left(m_x,m_y\right)$ of any pair of elementary rest masses appears to be (base-2) logarithmically fine-tuned with the fine structure constant at rest α. It is also very plausible that both big G and the set of elementary masses to be actually inter-correlated and both determined by a still unknown (more profound) law of nature, which may be in fact a general/universal propriety of spacetime itself.

In conclusion, $f\left(m_x,m_y\right)$ appears to help in predicting the products of any pair of elementary non-zero rest masses $m_x\cdot m_y$ as a function of Planck mass $m_{Pl}=\sqrt{\hbar c/G}$, so that:

$$m_x m_y \cong \frac{\hbar c/G}{2^{a\cdot(1\pm 0.2)}} \cong \frac{m_{Pl}{}^2}{2^{a\cdot(1\pm 0.2)}} \tag{2-2a}$$

The factor $n_a=2^a=2^{1/\alpha}\cong 1.8\times 10^{41}$ which emerges in the previous equation can be proposed as a unifying gravitational/mass scaling factor of the Standard model, so that:

$$m_x m_y \cong \frac{m_{Pl}{}^2}{n_a{}^{1\pm 0.2}} \Leftrightarrow \tag{2-2b}$$

$$\Leftrightarrow \sqrt{m_x m_y} \cong \frac{m_{Pl}}{n_a{}^{0.5\pm 0.1}} \tag{2-2c}$$

The existence of $n_a=2^a=2^{1/\alpha}$ in the function $f\left(m_x,m_y\right)\cong 1$ justifies the hypothesis that the fine structure constant may have a dual/hybrid electromagnetic and gravitational (electro-gravitational) significance, so that n_a may be regarded as a unifying electro-gravitational scaling factor with the propriety that $m_{Pl}/\sqrt{m_x m_y}\cong\left(n_a=2^a\right)\cong 1.8\times 10^{41}$ and $\log_2\left(n_a\right)=a$.

A similar base-2 logarithmic function $ff\left(r_x,r_y\right)$ can be conceived to compare the most important length scales of our universe in pairs $\left(r_x,r_y\right)$ such as:

$$ff\left(r_x,r_y\right)=\log_2\left(r_x/r_y\right)/a \Leftrightarrow \tag{2-3a}$$

$$ff\left(r_x,r_y\right)=\log_{na}\left(r_x/r_y\right) \tag{2-3b}$$

Given the estimated radius of our observable universe (**ou**) $R_{ou}\cong 4.4\times 10^{26}m$, the classical electron radius $r_{ec} = k_e q_e^2 / (m_e c^2) \cong 2.8 \times 10^{-15} m$, the radius of the proton (as determined by scattering using electrons) $r_p \cong 0.87 \times 10^{-15} m$ and the Planck length $l_{Pl} = \sqrt{\hbar G / c^3} \cong 1.62 \times 10^{-35} m$, for $r_x, r_y \in \{R_{ou}, r_{ec}, r_p, l_{Pl}\}$, $ff(r_x, r_y)$ has the following values: $ff(R_{ou}, l_{Pl}) \cong 1.49$, $ff(R_{ou}, r_e) \cong 0.99$, $ff(R_{ou}, r_p) \cong 1.01$, $ff(r_p, l_{Pl}) \cong 0.48$, $ff(r_e, l_{Pl}) \cong 0.49$. Interestingly, all these values tend to concentrate around values 1/2, 1 and 3/2 which are multiple integers of 1/2. The length $n_a \cdot r_{ec} \cong 5 \times 10^{26} m$ is relatively close to $R_{ou} \cong 4.4 \times 10^{26} m$, so that $n_a \cdot r_{ec} \cong 1.14 \cdot R_{ou}$ and $\log_2(R_{ou} / r_{ec}) \cong 136.85 \overset{99.9\%}{\cong} a$. The length $n_a \cdot r_p \cong 1.6 \times 10^{26} m$ is also relatively close to R_{ou} so that $n_a \cdot r_p \cong 0.35 \cdot R_{ou}$ and $\log_2(R_{ou} / r_p) \cong 138.54 \overset{101.1\%}{\cong} a$. In other words, when expressed in r_p and r_e units, the observable universe has ~137 length "octaves" which also suggests the gravitational significance of FSC. The next "natural" ff-value in the series $n/2\,(with\; n \in N^*)$ is $ff(R_x, l_{Pl}) \cong 2$, which predicts a radius $R_x = l_{Pl} n_a^2 \cong 10^{21} R_{ou}$ which is a potential candidate for the real radius of our present universe (which is already predicted by superstring theory to be with at least 3 orders of magnitude larger than R_{ou}).

$n_a^2 \cong 3.2 \times 10^{82}$ is also close to the gravity-related ratios between the rest-mass of our observable universe (**ou**) $M_{ou} \cong 3.1 \times 10^{54} kg$ and the non-zero rest masses of the proton (m_p) and electron (m_e), such as: $M_{ou} / m_p \cong (1.8 \times 10^{81} = N_{Edd})$, $M_{ou} / m_e \cong 3.4 \times 10^{84}$ and $M_{ou} / \sqrt{m_p \cdot m_e} \cong 7.9 \times 10^{82}$.

Additionally, $\sqrt{\frac{c}{(\pi/4) r_p n_a}} \cong 75.75[(km/s)/Mpc] \overset{105\%}{\cong} H_0$, with $H_0 \cong 71.9[(km/s)/Mpc]$ being the Hubble constant as determined by the latest measurements from 2016 with the Hubble telescope [12]. This n_a-based predicted value is very close to the first good estimate $H_0 \cong 75[(km/s)/Mpc]$ proposed in 1958 by the influent American astronomer Allan Sandage [13].

Additionally, $\sqrt{(\pi/4) a^3 n_a} \cong 6.01 \times 10^{23}$ is very close to the numerical value of the Avogadro constant $N_A \cong 6.023 \times 10^{23} (molec / mole)$, so that $\sqrt{(\pi/4) a^3 n_a} \overset{99.8\%}{\cong} N_A$.

Furthermore, n_a is a plausible candidate for the warp factor W proposed in Randall–Sundrum type 1 (**RS1**) universe model which proposes a 5D anti-de Sitter bulk space, with all EPs (except for the graviton) being localized on a (3 + 1)D brane or branes. This 5D space is extremely warped, a warp caused by the energy gradient between two branes with positive and negative energy respectively: a positive-energy "Planckbrane" (where gravity is a relatively strong force) and a negative-energy "Tevbrane" (our home with the Standard Model particles): in RS1 these two branes are separated in the 5th dimension (which is not necessarily large) by approximately 16 energy/length units (as based on the brane and bulk energies). The warping (or red-shifting) of the 5th extra spatial dimension is analogous to the warping of spacetime in the vicinity of any massive object as proposed by Einstein in his General Relativity Theory (**GRT**): this warping generates a large ratio of energy scales between the Planckbrane and the Tevbrane, so that the natural energy scale at one end of the extra dimension is much larger than at the other end [14,15].

3. THE HYPOTHETICAL ELECTRO-GRAVITON AS BASED ON THE ELECTRO-GRAVITATIONAL SIGNIFICANCE THE FINE STRUCTURE CONSTANT

$f(m_x, m_y) \cong 1$ can be also written as:

$$a \cong \log_2\left(\frac{\hbar c / \lambda}{G m_x m_y / \lambda}\right) \Leftrightarrow \tag{3-1a}$$

$$\Leftrightarrow \frac{\hbar c / \lambda}{G m_x m_y / \lambda} \cong \left(2^a = n_a\right) \Leftrightarrow \tag{3-1b}$$

$$\Leftrightarrow \frac{(\hbar / n_a)c}{\lambda} \cong \frac{Gm_x m_y}{\lambda} \quad (3\text{-}1c)$$

Based on previous equations, this paper proposes a model for the hypothetical spin-2 graviton analogous to the spin-1 photon (with wavelength λ and energy $E_{ph}(\lambda) = \hbar\lambda / c$), with zero-rest mass and moving with maximum speed c (or close to c , as the speed of gravitational waves [16]). As it is modeled analogous to the electromagnetic field quanta (the photons), this hypothetical graviton may be called "electrograviton" (eg), as it is also based on a (reduced) gravitational Planck-like constant $\hbar_{eg} \cong \hbar / n_a \cong 5.1 \times 10^{-76} Js$, so that an eg with wavelength λ is predicted to have an energy defined by:

$$E_{eg}(\lambda) = \hbar_{eg}\lambda / c \quad (3\text{-}2)$$

Measuring the value of FSC at rest (with very high accuracy attained by using experiments based on the quantum Hall effect) may be considered an indirect method to essentially determine the electro-gravitational scaling factor $n_a = 2^{1/\alpha} = 2^a$, which can further be used to redefine FSC at rest, such as:

$$a \overset{redef.}{=} \log_2(n_a) \quad (3\text{-}3a)$$

$$\alpha \overset{redef.}{=} 1 / a = 1 / \log_2(n_a) \quad (3\text{-}3b)$$

The existence of the hypothetical graviton (modeled in this paper as an electrograviton) may also imply the existence of subtle (at least theoretically distinguishable) subquantum states for any physical system (PS) (composed of one or more EPs) generated by the absorption of one or more egs [17,18,19]. The total number of possible (at least theoretically) distinguishable states of a PS (N_S) can be calculated as the product between the total number of quantum states (N_{qS}) and the total number of gravitonic (subquantum) states (N_{gS}), such as [20]:

$$N_S = N_{qS} \times N_{gS} \Rightarrow \quad (3\text{-}4a)$$

$$\Rightarrow \log_2(N_S) = \log_2(N_{qS}) + \log_2(N_{gS}) \quad (3\text{-}4b)$$

The absorption of one photon by a PS increases N_{qS} with one unit (one additional possible quantum state). Analogously, if hypothesized that the absorption of each individual eg adds a distinct supplementary possible subquantum (gravitonic) state to a receiver PS then (so that N_{gS} increases with one unit, one additional possible gravitonic/subquantum state), the absorption of (a number of) n_a egs means receiving $\log_2(n_a) \cong 137 gbits$ ([subquantum] gravitonic bits): on the other hand, the energy-absorption of n_a egs with $E_{eg}(\lambda) = \hbar_{eg}\lambda / c$ is equivalent to the absorption of one photon with the same wavelength λ and energy $E_{ph}(\lambda) = \hbar\lambda / c = n_a E_{eg}(\lambda)$; if the absorption of each individual photon adds a distinct supplementary possible quantum state to a receiver PS then, the absorption of a photon means receiving $1qbit \cong 137 gbits$. Each gbit represents a "octave"-like group of gravitonic states similar to the "octave" interval used in music to define any (double closed) interval of frequencies (f) $[f, 2f]Hz$.

FSC expresses an informational equivalence between electromagnetism and gravity and $a \cong 137$ may be used as an interconversion factor between qbits and gbits, so that FSC $(\alpha = 1 / a)$ can be regarded as the probability of targeting a specific subquantum (gravitonic) octave of states (defined by each gbit) of any PS. In this view, a photon can be defined as an EP containing $1qbit \cong 137 gbits$ so that the probability of a real electron/positron (at rest) to emit a real photon (Feynman's interpretation of FSC) may measure in fact the base-2 logarithmic probability of an electron/positron to emit a photon in a specific octave of subquantum (gravitonic) states.

The author of this paper had also demonstrated that n_a and the redefined $a \overset{redef.}{=} \log_2(n_a)$ can both help predicting a quantum gravitational coupling constant a_{Gq} for an electron/positron pair which approximates the empirical $\alpha_G = Gm_e^2 / (\hbar c) \cong 1.75 \times 10^{-45}$ with very high accuracy[1], such as:

[1] Discovered in 2014 and included in a document registered at the Romanian Copyright Office (ORDA) with the registration number 2546 / 26.03.2015. URL

$$\alpha_{Gq} = \frac{1}{2a^{3/2}n_a} \cong 1.74 \times 10^{-45} \overset{99.6\%}{\cong} a_G \qquad \text{(3-5a)}$$

This quantum a_{Gq} can be interpreted as a linearithmic probability and can also be used to predict a quantum big G scalar G_q with the same high accuracy, such as:

$$G_q = \alpha_{Gq} \cdot \hbar c / m_e^2, with$$
$$G_q \cong 6.648 \times 10^{-11} m^3 kg^{-1} s^{-2} \overset{99.6\%}{\cong} G \qquad \text{(3-5b)}$$

In conclusion, FSC may actually have a triple electro-gravito-informational significance, so that n_a can be considered a unifying (quantum/subquantum) electro-gravito-informational scaling factor, such as $1/n_a \cong 1/10^{41}$ can be interpreted as the probability to target a specific subquantum (gravitonic) state of any EP and $\alpha = 1/\log_2(n_a) \cong 1/137$ can be interpreted as the base-2 logarithmic variant of that (same) probability, which is the probability to target a specific octave of subquantum (gravitonic) states of any EP.

More ambitiously, this paper proposes $n_a \cong 10^{41}$ to be a first rank adimensional constant that may vary with the energy scale of measurement (as detailed later in this paper), but with its value at rest remaining constant on the entire history (including future) of our universe. This paper also proposes a contraction in the set of adimensional constants of the Standard Model, so that FSC to be redefined as $\alpha \overset{redef.}{=} 1/a = 1/\log_2(n_a)$, independently of the combination of dimensional constants $k_e q_e^2/(\hbar c) \cong 1/137$, constants which may be considered just (dimensional) second rank parameters with that combinational value fine-tuned near $1/a = 1/\log_2(n_a) \cong 1/137$.

4. THE DIMENSIONAL RELATIVITY HYPOTHESIS (DRH) BASED ON THE UNIFYING SCALING FACTOR n_a [1]

An interesting (probably just apparent) coincidence emerges when comparing h and $\hbar_{eg} (\cong \hbar / n_a)$ with a global (angular) momentum parameter of the observable universe (**ou**) at rest $L_{ou} = E_{ou} \cdot t_{ou} \cong 1.37 \times 10^{89} Js$: $E_{ou} \cong 3.14 \times 10^{71} J$ is the approximate resting energy of ou determined from the experimental measurements of the average energy density of ou (ρ_{ou}) which is estimated to be very close to the critical energy density established by the Friedmann model as $\rho_c = 3H_0^2/(8\pi G/c^2)$ so that $\rho_{ou} \cong \rho_c \cong 8.73 \times 10^{-10} J/m^3$ and the volume of ou $V_{ou} = (4\pi/3) R_{ou}^3 \cong 3.6 \times 10^{80} m^3$ (derived from the radius of ou $R_{ou} \cong 4.4 \times 10^{26} m$); $t_{ou} \cong 13.8 \times 10^9$ *years* is the age of the present ou (as determined by specific astrophysical methods).

$$d_{ph} = \log_{n_a}(L_{ou}/\hbar) \cong 2.98 \Leftrightarrow L_{ou} \cong \hbar n_a^3 \qquad \text{(4-1a)}$$

$$d_{eg} = \log_{n_a}(L_{ou}/\hbar_{eg}) \cong 3.98 \Leftrightarrow L_{ou} \cong \hbar_{eg} n_a^4 \qquad \text{(4-1b)}$$

The closeness of the positive reals d_{ph} and d_{eg} to the positive integers 3 and 4 respectively (denoting the number of apparent/perceptual dimensions of the 3D space alone and the 4D spacetime respectively, as gravity is modeled by General Relativity in a 4D Minkowski space) may suggest that the number of dimensions of ou may not be absolute, so that it may not be correct to (a priori) predefine the number of dimensions of space/spacetime as pure observational arbitrary parameters without also considering the type of gauge boson (photon, electrograviton, etc. and its specific (angular) momentum quantum $\hbar$, $\hbar_{eg}$, etc.) used to observe/measure that space/spacetime and its number of dimensions (d_x). An arbitrary d_x may be extracted from an arbitrary triad (L_x, n_x, h_x) as $d_x = \log_{nx}(L_x/h_x)$: this fact suggests that it may not be correct to define d_x a priori, based only on empirical/experimental observation, without also defining the triad (L_x, n_x, h_x) from which this d_x was extracted: this is because a fixed d_x (as we associate space with a 3D reference frame) also implies a fixed ratio $d_x = \log_{nx}(L_x/h_x) = \log_2(L_x/h_x)/\log_2(n_x)$, which also implies a strict correlation in the variation of all the elements of the triad $\left(L_x, N_x, h_x\right)$.

Given the relativity of $d_x = \log_{nx}\left(L_x / h_x\right)$ from the triad $\left(L_x, N_x, h_x\right)$, this paper launches the dimensional relativity hypothesis (DRH) which states that: "the dimensions (D) of the observable universe (ou) may not be Euclidean but fractal and the number of dimensions (d) of ou may not be absolute (a priori defined) and integer but relative and fractionary, depending on the electro-gravito-informational unifying scaling factor n_a and the (angular) momentum "key"-quantum we use to study the global angular momentum L_{ou} (using our mind, senses and their extensions as observational/measuring tools)". As we generally use light (photons) to perceive and study space (together with virtual photons which were demonstrated to permeate all space, as proved by the Casimir effect), the fact that $L_{ou} \cong \hbar n_a^{\ 3}$ may generate the "3D space" appearance: there are studies which also show that time may not exist as a "4th dimension" in the relativistic microcosm (the quantum level of reality). The fact that we perceive time at the macroscopically level (as part of an apparent "4D spacetime", with a 4th dimension modeled and measured using a classical linear time function) may be also an appearance generated by gravity (mediated by [electro]gravitons with the very small $\hbar_{eg}$ momentum-quantum) and to the relation $L_{ou} \cong \hbar_{eg} n_a^{\ 4}$.

The human brain uses photons (light) to observe an apparent "empty" space, so that it may be the "victim" of the illusion governed by $d_{ph} \cong 3$, which generates the appearance of a "3D spacetime", in which time is not an additional 4th dimension, but only an abstract/artificial function which records a sequence of changes/events in that 3D space. The human brain also uses a combination of photons (light) and (quantized) gravity to observe the movements of objects in space, so that it may be also the "victim" of the illusion governed by $d_{eg} \cong 4$, which generates the appearance of a "4D spacetime", with an additional spatial 4th dimension attached to a perceptual "3D space".

This hypothesis can also offer an escape from a potential tautology, as when we measure different parameters of a quantum particle (QP), we use algorithms and equations based on the a priori assumption that space has three (Euclidean or non-Euclidean) dimensions $\left(d_x = 3\right)$, which may be essentially an illusion created by $d_{ph} \cong 3$: it is also the case in this paper, when V_{ou} was calculated using the same 3D space a priori assumption.

As $L_{ou} = E_{ou} \cdot t_{ou}$ is a function of both the energy E_{ou} and age t_{ou} of ou, a generalized function $d_x\left(E_x, t_x, h_x\right)$ can be defined next:

$$d_x\left(E_x, t_x, h_x\right) = \log_{na}\left(E_x \cdot t_x / h_x\right) \qquad \text{(4-2a)}$$

$d_x\left(E_x, t_x, h_x\right)$ predicts that if we could (theoretically) existed and could have used the same photons with the same $h_x = \hbar$ (as the present photons have) in a very early historical epoch of ou (defined by $t_x << t_{ou}$, the same $E_x = E_{ou}$ and the same n_a) our space would have looked more like a ~2.5D space (like in the first second after the hypothetical Big Bang) or even ~1.5D (like in the first Planck time interval $t_{Pl} = \sqrt{\hbar G / c^5} \cong 5.39 \times 10^{-44} s$ after the hypothetical Big Bang):

$$d_x\left(E_{ou}, 1s, \hbar\right) \cong 2.56 \qquad \text{(4-2b)}$$

$$d_x\left(E_{ou}, t_{Pl}, \hbar\right) \cong 1.51 \qquad \text{(4-2c)}$$

$d_x\left(E_x, t_x, h_x\right)$ also predicts that if we would (at least theoretically) exist and use the same photons with the same $h_x = \hbar$ (as the present photons have) in a very distant future of ou (defined by $t_x >> t_{ou}$, the same $E_x = E_{ou}$ and the same n_a) our space would have looked more like a ~4D space, for example in the future moment corresponding to the age of $t_x \cong 10^{50} years$ measured after the hypothetical Big Bang:

$$d_x\left(E_{ou}, 10^{50} years, \hbar\right) \cong 3.95 \qquad \text{(4-2d)}$$

More interestingly, all known elementary particles (EPs) (including those EPs with extreme low/high non-zero rest masses like the neutrinos [nn] and the Higgs [H] boson, except the photon and gluon) have non-zero rest energies in the interval $\left[E_{nn}\left(\cong 1.85eV\right), E_H\left(\cong 125GeV\right)\right]$ which is relatively "centered" in $\sqrt{E_{nn}\cdot E_H}\cong 0.5MeV$ (more or less ~5-6 orders of magnitude): $d_{EP}=\log_{na}\left(E_{ou}/E_{EP}\right)$ has values in the interval $[1.9,\ 2.2](D)$ which is relatively centered around 2(D). This may explain why QPs (first treated as superstrings by the string theories [STs]) can also be generalized and modeled as 2D surfaces (supermembranes or 2-branes) that may exist in an 11D spacetime as proposed by M-Theory (MT) and supergravity theory (which combines the principles of supersymmetry and general relativity). A n_a -based 11D universe may have a total angular momentum $L_{tot}\cong\hbar_{eg}n_a^{11}$. In this view, bosons may be modeled as open 2-branes and fermions may be modeled as closed 2-branes [21,22]. The same QPs may be regarded as 2-branes in a 4D spacetime or as 1-branes (strings) in a 2D (holographic) universe: this sustains the holographic principle (HP) proposed by Gerard't Hooft's but also the AdS/CFT correspondence (aka Maldacena duality or gauge/gravity duality).

The definition $d_x=\log_{na}\left(L_{ou}/h_x\right)$, can be used to inversely define a specific (angular) momentum quantum associated to any d-frame of reference (with a number of d dimensions) such as:

$$hf\left(d\right)=L_{ou}/n_a^{\ d} \tag{4-3a}$$

$hf\left(3\right)\cong 2.4\times 10^{-35}Js$ is relatively close (with approximately the same order of magnitude) to the reduced Planck constant $\left(\hbar\right)$, so that $hf\left(3\right)\cong 0.23\hbar$. The rest energies of W/Z bosons $E_W\cong 80.4GeV$, $E_Z\cong 91GeV$ and their mean (measured) lifetimes $t_W\cong t_Z\cong 3\times 10^{-25}s$ may help defining two reduced (angular) momentum-like quanta $\hbar_W$ and $\hbar_Z$ (with 2π being associated with a full mean lifetime $t_{W/Z}$), such as:

$$\hbar_W=\frac{E_W\cdot t_W}{2\pi}\cong 6\hbar\cong 26hf(3) \tag{4-3b}$$

$$h_Z=E_Z\cdot t_Z\cong 7\hbar\cong 29hf(3) \tag{4-3c}$$

h_W and h_Z are relatively close but larger than $hf\left(3\right)\cong 0.23\hbar$ (with ~1 order of magnitude), and that is why the W/Z bosons may be considered "heavy" photons, or high-momentum photons (unstable excited states of the photon with non-zero rest energies/masses and tendency to decay asymmetrically into pairs of distinct leptons) which is also the essential part in the successful unification of electromagnetic field (EMF) and the weak nuclear field (WNF) as the electroweak field (EWF). As $d_{W(Z)}=\log_{na}\left(L_{ou}/\hbar_{W(Z)}\right)\cong 2.97\to 3$, observing our space by using W/Z bosons also generates the same 3D space appearance.

Analogous to $\hbar_W$ and $\hbar_Z$, one can also calculate a reduced (angular) momentum-like quantum for the Higgs boson (HB) $\hbar_H$ by using the HB non-zero rest energy $E_H\cong 125GeV$ and its mean lifetime $t_H\cong 1.56\times 10^{-22}s$ (with 2π being associated with a full mean lifetime t_H), such as:

$$\hbar_H=\frac{E_H\cdot t_H}{2\pi}\cong 4718\hbar\cong 20770hf(3) \tag{4-3d}$$

L_H is with ~3-4 orders of magnitude larger than $hf\left(3\right)\cong 0.23\hbar$ and that is why HB may be considered a "very heavy" photon, or very-high-momentum photon (a very high and unstable excited state of the photon with a non-zero rest energy/mass and tendency to decay symmetrically into pairs of identical/opposite-charge W/Z bosons, photons, leptons). As $d_H=\log_{na}\left(L_{ou}/\hbar_H\right)\cong 2.9\to 3$, observing our space by (at least theoretically) using HBs may also generate the same 3D space appearance.

Based on $hf\left(d\right)$ function, DRH also predicts and defines a quantum G function Gf_q associated to any integer/fractional dimensional d-frame (with d dimensions), such as:

$$Gf_q\left(d\right)=\left(\alpha_{Gq}\cdot c/m_e^{\ 2}\right)\cdot hf\left(d\right), \tag{4-4a}$$

with $G_q \cong Gf_q(4) \cong G$ (4-4b)

Based on the $Gf_q(d)$ general definition, DRH predicts a hypothetical (very plausible) strong gravity constant (SGC) associated with a 3D frame and generated by a strong gravity field (SGF) measured by a quantum momentum close to $hf(3) \cong h$, such as:

$$\Gamma \cong Gf_q(3) \cong 10^{31} m^3 kg^{-1} s^{-2} \text{ and} \quad (4\text{-}5a)$$

$$\Gamma \cong 1.5 \times 10^{41} G \quad (4\text{-}5b)$$

The majority of authors have calculated a value for this hypothetical SGC (Γ) from $\Gamma_{\inf} \cong 10^{25} m^3 kg^{-1} s^{-2}$ (corresponding to $d_{\inf} \cong 2.84$) up to $\Gamma_{\sup} \cong 10^{37} m^3 kg^{-1} s^{-2}$ (corresponding to $d_{\sup} \cong 3.14$), with most of estimations between $10^{28} m^3 kg^{-1} s^{-2}$ and $10^{32} m^3 kg^{-1} s^{-2}$, with a average $d_{avr} \cong 3$. (Seshavatharam and Lakshminarayana S. [23,24,25]; Perng [26]; Fisenko et al. [27,28,29]; Recami et al. [30,31,32]; Fedosin [33,34,35]; Tennakone [36]; Stone [37]; Oldershaw [38,39]; Mongan [40]; Sivaram and Sinha [41]; Dufour [42]).

SGF may act as a confinement force between the 2-branes contained in the same 3-brane (like our 3D space) stabilizing that 3-brane.

Furthermore, DRH also predicts that there may exist a set of very strong gravity fields (VSGF) associated to the 2D (the frame of 2-branes) and 1D (the frame of strings/1-branes) which may manifest at scales progressively smaller and even smaller the Planck length scale, such as:

$$Gf_q(2) \cong 10^{72} m^3 kg^{-1} s^{-2} \cong 10^{82} G \quad (4\text{-}6a)$$

$$Gf_q(1) \cong 10^{113} m^3 kg^{-1} s^{-2} \cong 10^{123} G \quad (4\text{-}6b)$$

VSGF (2) is associated with $Gf_q(2)$ and may act as a confinement force between the strings contained in the same 2-brane stabilizing that 2-brane. VSGF (1) is associated with $Gf_q(1)$ and may act as a confinement force between the points contained in the same 1-brane (string), stabilizing that 1-brane.

$Gf_q(1)$ is a potential candidate for the upper bound of a plausible finite G that limits the growth to infinity of the strength of gravity when approaching infinitesimal length scales possibly inferior to the Planck length scale (as possibly in the black holes): the predicted hypothetical asymptotical freedom of gravity.

DRH also proposes a generalized electrograviton model (EGM) in which there is a distinct electrograviton (0-spin, 1-spin or 2-spin) associated with each dD frame (with d being a positive integer number of dimensions) with its own specific angular quantum momentum, such as:

$$hf_{eg}(d) = L_{ou} / n_a{}^d \quad (4\text{-}7a)$$

$$\text{and } Gf_q(d) = \left(\alpha_{Gq} \cdot c / m_e{}^2\right) \cdot hf_{eg}(d) \quad (4\text{-}7b)$$

In this view, the Newtonian/relativistic gravity is mediated by the 4D-frame electrograviton (4-eg), with an angular quantum momentum measured by $\hbar_{eg} \cong hf_{eg}(4)$ which generates a gravitational field with strength measured by $G \cong Gf_q(4)$. In the same view, SGF is predicted to be mediated by a 3D-frame electrograviton (3-eg) with $hf_{eg}(3) \cong \hbar$, which has a strength also measured by $\Gamma \cong Gf_q(3) \cong 1.5 \times 10^{41} G$. The photon (which is its own antiparticle), the W/Z bosons and HB may all be considered different types of 3-egs because $d_H \cong d_{W(Z)} \cong d_{ph} \cong 3$.

In this way, the DRH-based SGF may co-predict (retrodict) the existence of the Higgs field (HF), as the 3D-frame eg (3-eg) has some striking scalar similarities with HB, which is a scalar QP (the only known scalar QP in nature, first predicted to exist in 1960s) with 0-spin and even parity. HB is defined as the quantum excitation of one [of the four] components of HF: HB is a very plausible candidate for the 3-eg (predicted by DRH) and vice versa.

This DRH sub-hypothesis also implies that $Gf_q(d_H) \cong Gf_q(3) \cong \Gamma$. However, the mainstream considers that more studies are needed to firmly confirm if the ~125GeV boson discovered in CERN's Large Hadron Collider (LHC) has properties matching those predicted by Standard Model (SM) for HB, or whether, more than one type of HB exist (as predicted by some theories). The 100% confirmation of HF existence depends on the final confirmation of HB existence, as HF is detected through its excitations (the HBs, which are difficult to obtain and detect).

HF is predicted to be tachyonic (as the symmetry-breaking of HB [through condensation] only occurs under certain conditions), and has a "Mexican hat" shaped potential with non-zero strength at any distance (also manifesting in empty space and permeating the entire observable universe and possibly all our universe, similar to both electromagnetic field (EMF) and the predicted SGF.

In its vacuum state, HF breaks the weak isospin symmetry of the electroweak field (EWF) and generates the W and Z bosons of WNF, which have very large non-zero rest masses of about (80-90)GeV. HF may also explain the non-zero rest masses of other elementary QPs like quarks and leptons (that are predicted to be normally massless when considering the symmetries controlling their interactions), by using other HF-based mechanisms alternative to the Higgs mechanism.

$f\left(m_x, m_y\right)$ can be generalized/extended for any (reduced) Planck-like constant $\hbar_x \in \left\{\hbar, \hbar_W, \hbar_Z, \hbar_H\right\}$, such as:

$$f\left(m_x, m_y, \hbar_x\right) = \frac{\log_2\left[\hbar_x c / \left(G m_x m_y\right)\right]}{\hbar_x c / \left(k_e {q_e}^2\right)} \quad (4\text{-}8)$$

All fermionic EP non-zero rest masses can be considered the result of symmetry breaking of high-momentum bosons (like the W/Z and HB) but keeping $f\left(m_x, m_y, \hbar_x\right)$ close and centered on value 1. Not only “injecting” energy in a photon (by frequency increase of that photon) may generate fermionic particle-antiparticle pairs (with non-zero rest masses), but also injecting momentum in a photon may generate “(very) heavy photons” (like W/Z bosons and HB) which further decay in fermionic pairs.

DRH considers very plausible the possibility that the symmetry-breaking condensation of HB to also generate not-only the W/Z-bosons (also 3-egs), but also the 4-egs which mediate the gravitational field (GF): this implies GF to be a residual SGF (SGF may also be a residual VSG[2], as VSG[2] may be a residual VSG[1]), and may contribute to the n_a-based explanation of the hierarchy problem, as $Gf_q\left(d_H\right) / Gf_4\left(3\right) \cong n_a$ (with an approximate same order of magnitude).

DRH also predicts that VSGFs are probably mediated by the 1/2D-frame egs (1-egs and 2-egs) quantized by $hf_{eg}\left(1\right)$ and $hf_{eg}\left(2\right)$, which generates $Gf_q\left(1\right)$ and $Gf_q\left(2\right)$ and may also have 0-spin and even parity (like HB and the 3-eg).

In checkpoint conclusion, DRH (as based on the universal scaling factor n_a) offers important explanations and predictions (mainly the generalization of the electrograviton model for any relative frame with d dimensions).

We can also define a (generalized) reduced (angular) momentum-like quantum $\hbar_x$ for any bosonic or fermionic EP or non-EP with non-zero rest energy E_x (with 2π being associated with a full mean lifetime t_x of that particle) so that:

$$\hbar_x\left(E_x, t_x\right) = \frac{E_x \cdot t_x}{2\pi} \quad (4\text{-}9)$$

As $\hbar_x\left(E_x, t_x\right)$ can be applied to fermions also, the values of $\hbar_x\left(E_x, t_x\right)$ and $d_x\left(L_{ou}, \hbar_x\right) = \log_{na}\left(L_{ou} / h_x\right)$ for the main elementary/composite fermions (the electron[e], the muon[μ], the tauon[τ], the up-quark [u] from the free proton/hydrogen atom, the down-quarks [d1 and d2] from the free proton and from the free neutron respectively, the charm-quark [c], the strange-quark [s], the top-quark [t], the bottom-quark [b], the proton[p] and the unstable free neutron[n]) based on their rest energies ($E_e \cong 0.5MeV$, $E_\mu \cong 106MeV$, $E_\tau \cong 1777MeV$, $E_u \cong 2MeV$, $E_{d(1,2)} \cong 5MeV$, $E_c \cong 1290MeV$, $E_s \cong 100MeV$, $E_t \cong 173GeV$, $E_b \cong 4GeV$, $E_p \cong 938MeV$ and $E_n \cong 940MeV$) and their estimated mean lifetimes ($t_e \cong 10^{26} yrs$, $t_\mu \cong 10^{-6} s$, $t_\tau \cong 10^{-13} s$, $t_u \cong t_{d1} \cong t_p \cong 10^{31} yrs$, $t_{d2} \cong t_n \cong 886s$, $t_c \cong 10^{-12} s$, $t_s \cong 10^{-8} s$,

$t_t \cong 10^{-25}s$ and $t_b \cong 10^{-12}s$) are represented in the Table 2.

Table 2. The value of $\hbar_x(E_x,t_x)$ and d_x for the main known particles of our universe

$\hbar_x(E_x,t_x)$	d_x
$\hbar_e = \hbar_x(E_e,t_e) \geq 1.8\times10^{54}\hbar$	$d_e \cong 1.7D$
$\hbar_\mu = \hbar_x(E_\mu,t_\mu) \cong 5.6\times10^{16}\hbar$	$d_\mu \cong 2.6D$
$\hbar_\tau = \hbar_x(E_\tau,t_\tau) \cong 1.2\times10^{11}\hbar$	$d_\tau \cong 2.7D$
$\hbar_u = \hbar_x(E_u,t_u) \cong 1.8\times10^{59}\hbar$	$d_u \cong 1.5D$
$\hbar_{d1} = \hbar_x(E_d,t_{d1}) \cong 3.7\times10^{59}\hbar$	$d_{d1} \cong 1.5D$
$\hbar_{d2} = \hbar_x(E_d,t_{d2}) \cong 1\times10^{24}\hbar$	$d_{d2} \cong 2.4D$
$\hbar_c = \hbar_x(E_c,t_c) \cong 3.4\times10^{11}\hbar$	$d_c \cong 2.7D$
$\hbar_s = \hbar_x(E_s,t_s) \cong 3\times10^{14}\hbar$	$d_s \cong 2.6D$
$*\hbar_t = \hbar_x(E_t,t_t) \cong 21\hbar$	$*d_t \cong 3D$
$\hbar_b = \hbar_x(E_b,t_b) \cong 1.6\times10^{12}\hbar$	$d_b \cong 2.7D$
$\hbar_p = \hbar_x(E_p,t_p) \geq 7.2\times10^{61}\hbar$	$d_p \cong 1.5D$
$\hbar_n = \hbar_x(E_n,t_n) \geq 2\times10^{26}\hbar$	$d_p \cong 2.3D$

It is noticeable that $\hbar_x(E_x,t_x)$ corresponding to the main known fermionic particles except the top-quark (**t**) (marked * in the previous table) has values with many (11 to 61) orders of magnitude larger than $\hbar_x \in \{\hbar, \hbar_W, \hbar_Z, \hbar_H\}$ and dimensional d-frames with d_x values condensing around ~1.5D and ~2.5D: this is an important distinction between fermions and bosons (which have d_x values around $d_{ph} \cong 3D$ and $d_{eg} \cong 4D$ if considering the existence of the hypothetical electrograviton). Interestingly, the top-quark shares the same ~3D frame with the bosons.

There is also an interesting dimensional correspondence between quarks and leptons, such as the electron, the up-quark and the down quark from the free proton all share the same ~1.5D frame (which is also the frame of the proton). The other heavier (and short-lived) leptons share the same ~2.5D frame with the other heavier (and more unstable) quarks.

Interestingly, the (reduced) (angular) quantum momentum of the photon $(\hbar)$ acts as a "cut-off" quantum momentum of nature, as all particles with $\hbar_x(E_x,t_x) > \hbar$ are predicted to have non-zero rest masses (as in the majority of fermions and bosons) and all particles with $\hbar_x(E_x,t_x) \leq \hbar$ are predicted to have zero-rest masses (only relativistic masses, as in the case of the photon and the hypothetical electrograviton).

The existence of the "empty" ~2D and ~3.5D frames (which aren't shared by any known particles) may be in fact an indirect proof for the existence of other (still unknown) particles that may "occupy" this apparently "empty" d-frames with $\hbar_x(E_x,t_x)/\hbar \overset{\cong}{\in} [10^{35},10^{45}]$ (for the ~2D frame) and $\hbar_x(E_x,t_x)/\hbar \overset{\cong}{\in} [10^{-30},10^{-20}]$ (for the ~3.5D frame).

5. THE PREDICTION OF A GRAVITATIONAL FIELD VARYING WITH THE ENERGY SCALE

This paper also proposes a set of three simple n_a -based functions to describe three hypothetical variations of the gravitational field (**GF**) strength as measured by the quantum gravitational coupling constants a_{Gq1}, a_{Gq2} and a_{Gq3}, with a variable energy scale $E \in [E_e, E_{Pl}]$, with $E_e = m_e c^2 (\cong 0.51 MeV)$ and $E_{Pl} = \sqrt{\hbar c^5 / G} (\cong 1.22\times10^{19} GeV)$ (the Planck energy at which unification of all the four fundamental forces is predicted to occur), such as:

$$\alpha_{Gq1}(E) = n_a^{\frac{E_{\text{var}}}{E_{Pl}}} \frac{1}{2a^{3/2}n_a} \quad \text{and} \qquad (5\text{-}1a,b)$$
$$G_{q1}(E) = \alpha_{Gq}(E)\cdot \hbar c / m_e^2$$

$$\alpha_{Gq2}(E) = n_a^{2\frac{E_{var}}{E_{Pl}}} \frac{1}{2a^{3/2} n_a} \text{ and} \quad (5\text{-}1c,d)$$

$$G_{q2}(E) = \alpha_{Gq2}(E) \cdot \hbar c / m_e^2$$

$$\alpha_{Gq3}(E) = n_a^{3\frac{E_{var}}{E_{Pl}}} \frac{1}{2a^{3/2} n_a} \text{ and} \quad (5\text{-}1e,f)$$

$$G_{q3}(E) = \alpha_{Gq3}(E) \cdot \hbar c / m_e^2$$

$G_{q1}(E_{Pl}) \cong 1.2 \times 10^{31} m^3 kg^{-1} s^{-2}$ reaches $Gf_q(3)$, $G_{q2}(E_{Pl}) \cong 10^{72} m^3 kg^{-1} s^{-2}$ reaches $Gf_q(2)$ and $G_{q3}(E_{Pl}) \cong 10^{113} m^3 kg^{-1} s^{-2}$ reaches $Gf_q(1)$. The base-10 logarithmic variation of the functions $p_1(E) = \log_{10}[\alpha_{Gq1}(E)]$, $p_2(E) = \log_{10}[\alpha_{Gq2}(E)]$ and $p_3(E) = \log_{10}[\alpha_{Gq3}(E)]$ for $E \in [E_e, E_{Pl}]$ are represented in the Fig. 3:

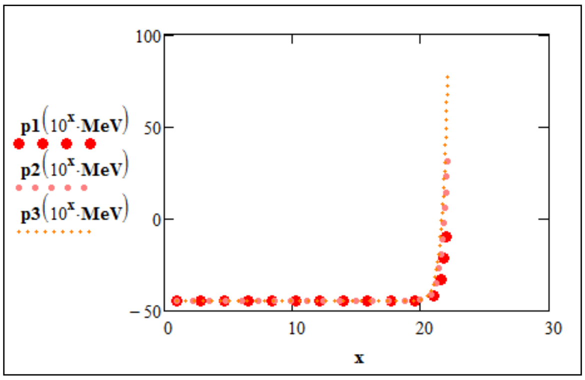

Fig. 3. The variation of the gravitational field strength described by the functions $p_1(E)$, $p_2(E)$ and $p_3(E)$

This approach also offers the possibility of a vacuum energy density ρ_{vac} that varies inverse-proportionally to the length scale λ (and direct-proportionally to the energy scale E), which may fill the huge "gap" (varying from 40 to more than 100 orders of magnitude) between the observed small ρ_{vac} used by general relativity and the very large ρ_{vac} predicted by the quantum field theory.

$$\rho_{vac}(\lambda) = \frac{\Lambda c^2}{8\pi G_{q(1,2,3)}(\lambda)} \quad (5\text{-}2)$$

6. A UNIFICATION PATTERN OF ALL THE FOUR FUNDAMENTAL FIELDS AT PLANCK ENERGY SCALE

The running coupling constant of the electromagnetic field (EMF) α determined in quantum electrodynamics (QED) using the beta function can be also written as the function of a variable energy scale $E >> E_e (= m_e c^2 \cong 0.51 MeV)$, $E \leq E_{Pl}$ and $\alpha \cong 1/137$, such as [43,44]:

$$\alpha_f(E) \cong \frac{\alpha}{1 - \frac{\alpha}{3\pi} \ln\left[(E/E_e)^2\right]} \text{ or} \quad (6\text{-}1a)$$

$\alpha_f(E)$ may be interpreted/explained and redefined as the consequence of the variation of n_a with a variable energy scale E, as described by the function:

$$nf_a(E) = n_a / (E/E_e)^{\frac{\ln(4)}{3\pi}}, \quad (6\text{-}1b)$$

$$\text{with } \alpha f(E) \cong 1/\log_2[nf_a(E)] \quad (6\text{-}1c)$$

The running coupling constant of the weak nuclear field (WNF) α_W includes the rest energies of the W/Z bosons (which are the propagators of the WNF) and is also based on the Fermi coupling constant $G_F/(\hbar c)^3 \overset{\text{exp.}}{\cong} 1.1663787 \times 10^{-5} GeV^{-2}$ (with $G_F \cong 1.43585 \times 10^{-62} Jm^3$), which can be indirectly determined by measuring the muon lifetime experimentally. α_W can be also written as a function of a variable energy scale $E \in [E_e, E_{Pl}]$, the rest mass/energy of the W$^{+/-}$ boson m_W and $E_W = m_W c^2$ such as [45,46,47,48]:

$$\alpha f_W(E) \cong \frac{E_W{}^2 G_F / (\hbar c)^3}{e^{E_W/E}} \quad (6\text{-}2)$$

The running coupling constant of the strong nuclear field (SNF) α_S determined in quantum chromodynamics (QCD) (also) using the beta function can also be written as a function of a variable energy scale $E >> E_{SNF}$, $E \leq E_{Pl}$ and

$E_{SNF} \cong 210(\pm 40)\,MeV$ (the QCD energy scale of quark confinement as determined experimentally), such as [49]:

$$\alpha f_S(E) \cong \frac{2\pi}{7\ln(E/E_{SNF})} \qquad (6\text{-}3)$$

The approximated running coupling constants of GF, EMF, SNF and WNF can all be represented on the same graph using the base-10 logarithmic functions $p_{GF1}(E)=\log_{10}\left[\alpha_{Gq1}(E)\right]$, $p_{GF2}(E)=\log_{10}\left[\alpha_{Gq2}(E)\right]$, $p_{GF3}(E)=\log_{10}\left[\alpha_{Gq3}(E)\right]$, $p_{EMF}(E)=\log_{10}\left[\alpha f(E)\right]$, $p_{WNF}(E)=\log_{10}\left[\alpha f_W(E)\right]$, $p_{SNF}(E)=\log_{10}\left[\alpha f_S(E)\right]$: see the Fig. 4.

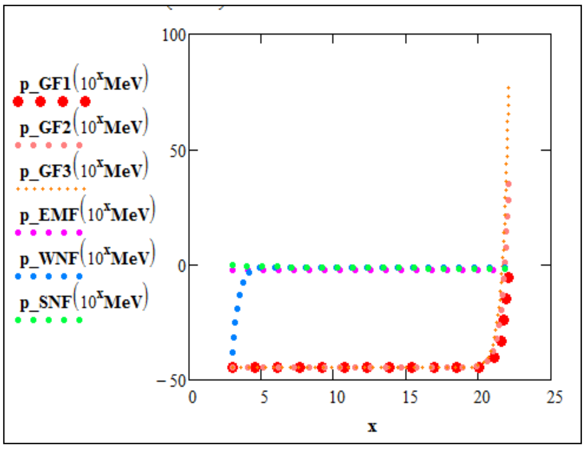

Fig. 4. A unification pattern of GF(1,2,3), EMF, SNF and WNF at the Planck energy scale

7. CONCLUSION

The (running) global scaling factor $nf_a(E)=n_a/(E/E_e)^{\frac{\ln(4)}{3\pi}}$, the redefinition of the (running) fine structure constant $\alpha f(E)\cong 1/\log_2\left[nf_a(E)\right]$ (which implies the contraction of both adimensional parameters into a single one, which is also associated with a plausible fine-tuning of both big G magnitude and all elementary rest masses), the dimensional relativity hypothesis (DRH) (including the generalized electrograviton model), the set of strong (and very strong) (running) gravity constants (measuring a gravitational field which varies with the energy scale) are all potential updates for the Standard Model of particle physics.

ACKNOWLEDGEMENTS

I would like to express all my sincere gratitude and appreciation to all my mathematics, physics, chemistry and medicine teachers for their support and fellowship throughout the years, which provided substantial and profound inner motivation for the redaction and completion of this manuscript.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Peer-review history:
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http://sciencedomain.org/review-history/20204