A strong zero-energy hypothesis (ZEH) applied on virtual particle-antiparticle pairs (VPAPs) predicting a new type of boson-fermion symmetry/"mass-conjugation", two distinct types of massless neutral fermions and a strong gravity field (SGF) which is well-balanced in strength with an electromagnetic field (EMF) possessing asymptotic freedom at Planck length scales

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DOI: 10.13140/RG.2.2.18441.88165 (URL-RG)
Article version: 1.0 (5.06.2020) (no matter this current paper version, its latest variant can be always downloaded from this URL; version 1.0 released on 5.06.2020)

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Andrei-Lucian Drăgoi[1,2]
(independent researcher)

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Abstract
(with main abbreviations used in this paper)

This article proposes a simple but strong zero-energy hypothesis (**ZEH**), which is essentially an ambitious speculative extension of the famous zero-energy universe hypothesis (**ZEUH**) (updating ZEUH to an "extended ZEUH" version) applied on virtual particle-antiparticle pairs (**VPAPs**) produced by virtual photons or virtual gluons. ZEH ambitiously proposes (and predicts):

(1) **a new type of boson-fermion symmetry/"mass-conjugation"** based on a simple and elegant quadratic equation (with partially unknown coefficients) proposed by ZEH: all known rest masses of all elementary particles (**EPs**) in the Standard model (**SM**) of particle physics are redefined as real solutions of this simple quadratic equation; based on the same quadratic equation, ZEH indicates/predicts an **unexpected profound bijective connection between the three types of neutrinos and the massless bosons** (gluon, photon and the hypothetical graviton); **ZEH also offers a new interpretation of Planck length** as the approximate length threshold above which the rest masses of all known EPs have real number values (with mass units) instead of complex/imaginary number values (as predicted by the same unique equation proposed by ZEH); among other EPs, **ZEH also predicts the existence of two distinct types of massless neutral fermions** (correspondents/conjugates of the neutral Higgs boson and Z bosons) which both move at the speed of light and may be viable candidates for dark matter and dark energy;

(2) a strong quantum gravitational field (**SQGF**) (equaling the predicted strength of the electromagnetic field [**EMF**] at Planck scales, which EMF is also predicted to possess asymptotic freedom, similarly to the strong nuclear field [**SNF**]) implying a quantized spacetime (**ST**) composed from ST "voxels" (**STVs**) resulting in quantized/discrete distances at scales comparable to Planck length scales;

(3) ZEH is essentially a fundamental principle of electro-gravitational strength balance/symmetry at Planck scales, a principle which allows (as a sine-qua-non condition added to Heisenberg's uncertainty principle [**HUP**]) the existence of virtual particle-antiparticle pairs (**VPAPs**) from the first place;

(4) ZEH also conjectures the existence of a unique large (but finite!) maximum density allowed in our universe (**OU**) shared by the electron neutrino and the pre-Big Bang singularity (**pBBS**) (which is thus regarded as a "renormalized" gravitational quasi-singularity) with all the other known/unknown EPs (which are regarded as "crocks" of pBBS);

(5) ZEH also proposes the concept of "practical radius" of any known/unknown EP and a unique formula for calculating this practical radius for any type of EP (associated with a unique big G value formula for any given practical radius/length scale).

ZEH distinguishes by the contrast between its simplicity and the richness/diversity of explanations, correlations and predictions it offers. The author of this paper resonates to Dirac's vision on the importance of mathematical beauty in physical equations: "*The research worker, in his efforts to express the fundamental laws of Nature in mathematical form, should strive mainly for mathematical beauty [...]It often happens that the requirements and beauty are the same, but where they clash the latter must take precedence.*" [URL]; "*A theory with mathematical beauty is more likely to be correct than an ugly one that fits some experimental data"* (as he claimed in 1970 when referring to the renormalization of quantum electrodynamics which was Dirac's paradigm of a mathematically "ugly" theory) [URL].

Zero is not only a number, but the symbol of both Nothingness and Everythingness (because all positive and negative numbers can be regarded as "born" in pairs from the same Zero to which they are symmetrical): furthermore, zero not only plays an essential central role in mathematics, but it also has a central role in physics and is a fundamental link between these two sciences, in the context of a possibly valid zero-energy universe theory (**ZEUT**).

This paper continues (from alternative angles of view) the work of other past articles/preprints of the same author [**1**,**2**, **3**, **4**, **5**, **6**, **7**, **8**, **9**, **10**, **11**, **12**, **13**, **14**, **15**, **16**, **17**, **18**, **19**, **20**, **21**, **22**, **23**, **24**, **25**, **26**, **27**].

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1. A strong zero-energy hypothesis applied on pairs of virtual particles

Observation no. 1a (Obs1a) [1]. When analyzing all known elementary particles (**EPs**) from the Standard model (**SM**) of particle physics, one may easily observe that non-zero (**nz**) electromagnetic charge (**nzEMC**) is ONLY associated with EPs possessing non-zero rest masses/energies (**nzrmEPs**): a part of leptons (the electron, the muon, the tauon and their antiparticles), all known quarks (and their antiparticles: antiquarks) and a part of bosons (the W^+ boson and its antiparticle: the W^- boson): in other words, nature seems to state "*no nzEMC without nzrm <<storage/support>>*".

[1] **Email**: dr.dragoi@yahoo.com
[2] **Main pages**: dragoii.com (CV: cvrg.dragoii.com); rg.dragoii.com; academia.dragoii.com; vixra.dragoii.com; gsj.dragoii.com

Interestingly, when a virtual fermionic particle-antiparticle pair (**VPAP**) of EM-charged EPs (each with rest mass m_{EP} [3] and rest energy $E_{EP} = m_{EP}c^2$) spontaneously pops out from the EM-neutral (almost-)zero-energy vacuum (**ZEV**) (a phenomenon known as quantum fluctuation and explained by Heisenberg's uncertainty principle [**HUP**]), there also appears a *dichotomy(/gradient)* of the zero-EMC (of that local ZEV) between a positive (integer/fractional) EMC $q_{EP}(>0)$ (of the EP from that VPAP) and a negative (integer/fractional) EMC $q_{aEP}\left(\overset{def.}{=} -q_{EP}\right)$ (of the antiparticle [**aEP**] of that positive-EMC-EP with rest mass $m_{aEP}\left(\overset{def.}{=} m_{EP}\right)$), so that the total EMC of this VPAP remains zero: $\boxed{q_{VPAP} = q_{EP} + q_{aEP} = 0C}$.

In the same time (and considering that VPAP to pop out at relative rest and being composed from point-like EPs, when compared to the distance r between them at the exact moment of their spontaneous "birth" as a VPAP), there is ALSO a *dichotomy* between the positive (rest) energy of the two EPs composing that VPAP $\boxed{E_{EPs}\left[=\left(m_{EP}+m_{aEP}\right)c^2\right]\left(=2m_{EP}c^2=E_{ph}\right)(>0J)}$ (with $E_{ph} = hc/\lambda$ being the energy of the virtual photon with a specific maximum wavelength λ necessary and sufficient for creating that VPAP at rest) AND the negative energy of both gravitational and electromagnetic forces (**F**) of attraction between those two EPs (of that same VPAP) $\boxed{E_F = -\left(\left|E_g\right|+\left|E_q\right|\right)(<0J)}$, with $\boxed{E_g = Gm_{EP}^2/r}$ being the gravitational force (**GF**) (acting between those two point-like EM-charged EPs composing that same VPAP) and $\boxed{E_q = k_e q_{EP}^2/r}$ being the electromagnetic(electrostatic) force (**EMF**) (acting between any two point-like EM-charged EPs composing a VPAP at rest): $G\left(\cong 6.674\times10^{-11}m^3kg^{-1}s^{-2}\right)$ is the universal gravitational constant and $k_e\left(\cong 8.99\times10^9 Nm^2/C^2\right)$ is the Coulomb constant in vacuum, *presuming the gravitational and electrostatic inverse-square laws to be valid down to Planck scales*.

The initial principle based on Obs1a ("*no nzEMC without nzrm <<support>>*") would then translate to this principle: "*Zero-EMC dichotomy (in two opposite-sign eEMCs) <<sine-qua-non-ly>> needs a simultaneous energetic dichotomy between* positive *(total) rest energy/mass and* negative-energy *gravitational attractive force (obviously associated with a negative-energy electromagnetic attractive force between those eEMCs resulted from the dichotomy of that initial zero-EMC of the local ZEV)*". In other words, *EMC dichotomy seems to be produced only by mass-gravitation dichotomy (**MGD**)*. **Important note (1).** However, because the electron (/positron) is the lightest known EM-charged EP (with the electron neutrino being much lighter but EM-neutral), *nature has to use a subtype of MGD with sufficiently large massic/energetic gradient (measured by $E_{EPs}\left(=2m_{EP}c^2\right)$) to produce a VPAP composed of two EPs with opposite nzEMCs*. **Important note (2).** The boson-fermion *dichotomy* also sine-qua-non-ly depends on MGD and that is why *MGD appears to be the "most" fundamental dichotomy and phenomenon* in nature (and thus in physics too).

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<u>**A strong zero-energy hypothesis (ZEH) assigned to any VPAP of any EM-charged/non-charged EPs**</u>. Based on Obs1a, we launch a zero-energy hypothesis (**ZEH**) (essentially an ambitious speculative extension of the famous zero-energy universe hypothesis [**ZEUH**] updating ZEUH to an extended ZEUH variant [**16**]), which ZEH has three co-statements.

<u>**ZEH's 1st co-statement (ZEH-1) and its implications**</u>. Presuming the gravitational and electrostatic inverse-square laws to be valid down to Planck scales and considering a VPAP composed from two electromagnetically-charged EPs (**cEPs**) each with non-zero rest mass m_{EP} and energy $E_{EP} = m_{EP}c^2$, electromagnetic charge q_{EP} and negative energies of attraction $E_g = -Gm_{EP}^2/r$ and $E_q = -k_e\left|q_{EP}\right|^2/r$, the <u>**first co-statement of ZEH**</u> is expressed as:

$$\boxed{E_{EPs}+E_F=0} \Leftrightarrow \boxed{E_{EPs}=\left|E_F\right|} \qquad \textbf{(1a)},$$

which is equivalent to (see below)

$$\boxed{2m_{EP}c^2_{\left(=E_{ph}\right)} = Gm_{EP}^2/r+\left|E_q\right|} \quad \textbf{(1b)}$$

which, by dividing both terms with m_{EP}^2, is equivalent to (see below)

$$\boxed{2c^2/m_{EP\left(=E_{ph}/m_{EP}^2\right)} = G/r+\left|E_q\right|/m_{EP}^2} \quad \textbf{(1c)}$$

which is equivalent to (see below)

$$\boxed{m_{EP\left(=2c^2m_{EP}^2/E_{ph}\right)} = 2c^2/\left(G/r+\left|E_q\right|/m_{EP}^2\right)} \quad \textbf{(1d)}$$

Because the spectrum of nzrms m_{EP} of all known EPs is quantized (with the left term m_{EP} of the equation 1d [**Eq.1d**] taking only specific discrete values), ZEH automatically implies

[**3**] with the reserve that virtual EPs do not necessarily carry exactly the same rest mass/energy as their corresponding real EPs, although they always conserve energy and quantum angular momentum. Because vacuum is permeated by quantum fundamental physical fields (**FPFs**) like electromagnetic field (**EMF**), strong nuclear field (**SNF**), Higgs field (**HF**) etc., VPAPS are actually created by the splitting of the virtual bosonic carriers/propagators (and quanta!) of those fields (the photon, the gluon and the Higgs boson [**Hb**] respectively) which bosons are firstly "extracted" from (created out of) the vacuum by EMF, SNF or HF and then secondly split in various types of VPAPs. **For example**: (**1**) a virtual electron-positron pair is generated by a virtual photon (quanta of EMF, which "photonic" quanta is extracted from the vacuum by EMF and then splits to a VPAP); (**2**) a virtual quark-antiquark pair is generated by a virtual photon (as described by photon structure function) or a virtual gluon (quanta of SNF, which "gluonic" quanta is extracted from the vacuum by SNF and then splits to a VPAP); (**3**) HF also creates/extracts Hbs out of the quantum vacuum, which Hbs further split in various types of VPAPs. The existence of VPAPs was proved by both static Casimir effect (**CE**) and dynamic CE (even creating real photons from virtual photons [URL2]). **Note**. The collision of the two EPs (an EP and its anti-EP forming that VPAP) re-create the initial virtual boson once again (which boson may then re-split and so on) so that both the number of "creator" virtual bosons and the number of "created" VPAPs are actually in a dynamical equilibrium per unit of spacetime.

that both $\boxed{\phi_g \overset{def.}{=} G/r}$ and $\boxed{\phi_e \overset{def.}{=} k_e/r}$ (which compose the right term of **Eq.1d,** with $\boxed{E_g = \phi_g m_{EP}{}^2}$ and $\boxed{E_q = \phi_e q_{EP}{}^2}$) are actually *quantized* and *can only take discrete values*: furthermore, quantized $\phi_g\left(=G/r\right)$ and $\phi_e\left(=k_e/r\right)$ *also imply that* G, k_e, r *(and* $E_{ph}\left(=hc/r\right)$ implicitly) *can only take discrete quantized values, all values organized in six sets (each not necessarily but most probably containing distinct elements only) and all sets found in bijective relation to one another* (with G_i, $k_{e(i)}$, r_i, $\phi_{g(i)}\left(=G_i/r_i\right)$, $\phi_{e(i)}\left(=k_{e(i)}/r_i\right)$ and $E_{ph(i)}\left(=hc/r_i\right)$ all having the same generic integer index which marks their reciprocal bijective correspondence: for a finite number or types of EPs, the indexes n and i are also finite [**see next sets**]):

$$G \in \left\{G_1\left(=G_{\min}\right), G_2, G_3, \ldots G_n\left(=G_{\max}\right)\right\},$$

$$k_e \in \left\{k_{e(1)}\left(=k_{e(\min)}\right), k_{e(2)}, k_{e(3)}, \ldots k_{e(n)}\left(=k_{e(\max)}\right)\right\},$$

$$r \in \left\{r_1\left(=r_{\min}\right), r_2, r_3, \ldots r_n\left(=r_{\max}\right)\right\},$$

$$\phi_g \in \left\{G_1/r_1, G_2/r_2, G_3/r_3, \ldots G_n/r_n\right\},$$

$$\phi_e \in \left\{k_{e(1)}/r_1, k_{e(2)}/r_2, k_{e(3)}/r_3, \ldots k_{e(n)}/r_n\right\} \text{ and}$$

$$E_{ph} \in \left\{E_{ph(1)}, E_{ph(2)}, E_{ph(3)}, \ldots E_{ph(n)}\right\} \quad \textbf{(1e)}$$

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ZEH's 2nd co-statement (ZEH-2) and its implications. ZEH-2 specifically (and ambitiously) interprets the six sets based *on the existence of the bijective functions* $G_i = f\left(r_i\right)$, $k_{e(i)} = f\left(r_i\right)$ which imply that each of the six sets (previously defined) contains distinct (non-redundant) elements only. Furthermore, ZEH specifically interprets this implication in the sense that m_{EP} *is quantized in the group of all known nzrmEPs* because *both* ϕ_g *and* ϕ_e *are actually quantized (because* G, k_e *and* r *can only take reciprocally bijective discrete quantized values) and the rest mass of any nzrmEP* m_{EP} *is actually a function of these two quantized* ϕ_g *and* ϕ_e *ratios*; this important prediction/interpretation of ZEH is assumed as **ZEH's 2nd co-statement** which also defines m_{EP} as the solution of the next simple and elegant quadratic equation with unknown $x\left(=m_{EP}\right)$ (equivalent with ZEH's **Eq.1b** as both derived from **Eq.1a**):

$$\boxed{\phi_g x^2 - \left(2c^2\right)x + \phi_e q_{EP}{}^2 = 0} \quad \textbf{(2a)}$$

Eq.2a is easily solvable and has two possible conjugate solutions which are both positive reals if $\boxed{c^4 \geq \phi_g \phi_e q_{EP}{}^2 \geq 0}$:

$$\boxed{m_{EP}\left(=x\right) \underset{ZEH}{\overset{redef.}{=}} \frac{c^2 \pm \sqrt{c^4 - \phi_g \phi_e q_{EP}{}^2}}{\phi_g}} \quad \textbf{(2b)}$$

The realness condition $\boxed{c^4 \geq \phi_g \phi_e q_{EP}{}^2 \geq 0}$ implies the existence of a minimum distance between any two EPs (composing the same VPAP) $\boxed{r_{\min} = \left|q_{EP}\right|\sqrt{Gk_e}/c^2 \cong 10^{-1} l_{Pl}}$ (for $q_{EP(\cong e)} \in \left\{e, \pm\tfrac{1}{3}e, \pm\tfrac{2}{3}e\right\}$ and with l_{Pl} being the Planck length): obviously, for distances lower than $r_{\min}$ the previous equation has only imaginary solutions $x\left(=m_{EP}\right)$ for any charged EP; by this fact, **ZEH offers a new interpretation of the Planck length, as being the approximate distance under which charged EPs cannot have rest masses/energies valued with real numbers**; because k_e is actually slightly variable with the energy/length scale and currently defined as a function of the running coupling constant of the electromagnetic field (**EMF**) (varying with the energy scale E) $\alpha\left(E\right)$[**4**] such as $k_e\left(E\right) = \alpha\left(E\right)\hbar c/e^2$, $r_{\min}$ can be generalized as $r_{\min}\left(E\right) = \left(q_{EP}/\mathrm{e}\right)\sqrt{G\alpha\left(E\right)\hbar c}/c^2$ (and can slightly vary as such). Note that $r_{\min}$ can be additionally corrected to include the strong force (implying color charge) and/or weak force (implying weak charge) between any quark (or gluon and/or leptons coupling with the weak field) and its antiparticle (composing the same VPAP): however, these potential corrections are estimated to only slightly modify $r_{\min}\left(E\right)$ values so that they're not detailed this paper. **Important note**. $r_{\min}$ can be regarded as a "**practical radius**" of any EP, which is defined as the minimum surrounding radius/length needed for any conceivable real of virtual EP to spontaneously pop out from the vacuum at the first place: in this new light, spacetime can be regarded as being continuum and granular/quantized in the same time because it allows a smooth length/size transition between macrocosm and microcosm but doesn't allow any two virtual/real EPs to pop out closer than $r_{\min}$.

Both conjugate solutions (**2b**) of **Eq.2a** reconfirm that, **because** m_{EP} **has discrete values only,** ϕ_G **(plus** $E_g\left(=\phi_G m_{EP}{}^2\right)$ **implicitly) and** ϕ_e **(plus** $E_q\left(=\phi_e q_{EP}{}^2\right)$ **implicitly) should all have discrete values only**. More interestingly, for all neutral EPs (**nEPs**) with $q_{EP} = 0C$ (which implies $\phi_g \phi_e q_{EP}{}^2 = 0$) and $r \geq r_{\min}\left(>0m\right)$, **Eq.2b** predicts

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[4] the leading log approximation of $\alpha\left(E\right)$, which is only valid for large energy scales $E >> E_e$, with $f\left(\mathrm{E}\right) = \ln\left[\left(E/E_e\right)^{2/(3\pi)}\right]$ and $E_e\left(=m_e c^2\right)$ is the rest energy of the electron/positron

that m_{EP} may take these **two conjugate solutions**: **(1)** a non-zero positive value $\boxed{m_{EP} = \frac{c^2+\sqrt{c^4}}{\phi_g} = \frac{2c^2}{\phi_g}(>0kg)}$ (like in the case of all three types of neutrinos, the Z boson and the Higgs boson) AND **(2)** a zero (positive) value $\boxed{m_{EP} = \frac{c^2-\sqrt{c^4}}{\phi_g} = 0kg}$ (like in the case of the gluon and the photon which both have zero rest mass $m_{EP}(=0kg)$ and are assigned only relativistic mass/energy by the Standard model (**SM**) of particle physics, implying that both travel with the speed of light in vacuum).

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ZEH's 3^rd^ co-statement (ZEH-3) and its implications. ZEH-3 co-states that the two conjugated elementary mass solutions $\boxed{m_{EP} = \left(c^2 \pm \sqrt{c^4 - \phi_g \phi_e q_{EP}^2}\right)/\phi_g}$ **(of ZEH's main equation) actually define a boson-fermion pair (with conjugated masses) called here "conjugated boson-fermion pair" (CBFP).** ZEH-3 actually conjectures **a new type of boson-fermion symmetry/"mass-conjugation"** based on ZEH's main quadratic equation (with partially unknown coefficients): ZEH-3 mainly predicts **2 distinct types of massless neutral fermions** (with zero rest mass, which may be the main constituents of dark matter and dark energy) AND an **unexpected profound bijective connection between the three types of neutrinos and the massless bosons** (gluon, photon and the hypothetical graviton) (**see next**).

For the beginning, let us start to estimate the values of ϕ_g for the known EM-neutral EP (**nEP**). For $q_{EP}=0$, the conjugated solutions (**Eq.2b**) simplify for any nEP such as:

$$\boxed{m_{nEP} \underset{ZEH}{\overset{redef.}{=}} \frac{c^2 \pm c^2}{\phi_g}} \quad \textbf{(2c)},$$

resulting

$$\boxed{\phi_{g(nEP)} \underset{ZEH}{\overset{estim.}{=}} \frac{c^2 \pm c^2}{m_{nEP}}} \quad \textbf{(2d)}$$

Focusing on Higgs boson and Z boson and their ZEH-predicted correspondent/conjugated massless fermions. In a first step and noting as $u\left(=m^2kg^{-1}s^{-2}\right)$ the unit of measure of $\phi_g\left(=2c^2/m_{nEP}\right)$, ZEH directly calculates/estimates $\phi_{g(nEP)}$ for the Z boson (**Zb**) and Higgs boson (**Hb**) which have known nzrm such as:

$$\boxed{\phi_{g(Zb)} = 2c^2/m_{Zb} \cong 10^{42}u} \quad \textbf{(3a)}$$

$$\boxed{\phi_{g(Hb)} = 2c^2/m_{Hb} \cong 8\times 10^{41}u} \quad \textbf{(3b)}$$

ZEH-3 states (and predicts!) that both Zb and Hb have two distinct correspondent/conjugated massless neutral fermions called the "Z fermion" (**Zf**) (which shares the same $\phi_{g(Zb)}\left(\cong 10^{42}u\right)$ with Zb) and the "Higgs fermion" (**Hf**) (which shares the same $\phi_{g(Hb)}\left(\cong 8\times 10^{41}u\right)$ with Hb) with zero rest masses (calculated by using the previous **Eq.2c**) (thus both moving with the speed of light in vacuum and possessing only relativistic masses instead of rest masses):

$$\boxed{m_{Zf} = \left(c^2-c^2\right)/\phi_{g(Zb)} = 0kg} \quad \textbf{(3c)}$$

$$\boxed{m_{Hf} = \left(c^2-c^2\right)/\phi_{g(Hb)} = 0kg} \quad \textbf{(3d)}$$

Note that, in the case of Hb-Hf and Zb-Zf pairs, ZEH cannot estimate the common/shared $\phi_{e(Zb/f)}$ and $\phi_{e(Hb/f)}$ ratios, because the generic $\phi_g \phi_e q_{EP}^2$ product is nullified by $q_{EP}=0C$ of both Zb and Hb.

Focusing on all three types of neutrinos, photon, gluon and hypothetical graviton. In a second step, ZEH-3 estimates the lower bounds of $\phi_{g(nEP)}$ for all known three neutrinos, as deducted from the currently estimated upper bounds of nzrm of all three known types of neutrino: the electron neutrino (**en**) with nzrm $m_{en} < 1eV/c^2$, the muon neutrino (**mn**) with nzrm $m_{mn} < 0.17MeV/c^2$ and the tau neutrino (**tn**) with nzrm $m_{tn} < 18.2MeV/c^2$:

$$\boxed{\phi_{g(en)}\left(>2c^2/m_{en}\right) > \left(\cong 10^{53}u\right)} \quad \textbf{(4a)}$$

$$\boxed{\phi_{g(mn)}\left(>2c^2/m_{mn}\right) > \left(\cong 6\times 10^{47}u\right)} \quad \textbf{(4b)}$$

$$\boxed{\phi_{g(tn)}\left(>2c^2/m_{tn}\right) > \left(\cong 6\times 10^{45}u\right)} \quad \textbf{(4c)}$$

For now, obviously, ZEH-3 cannot directly estimate the exact values of $\phi_{g(nEP)}$ for the photon (**ph**) $\phi_{g(ph)}\left(=0/m_{ph}\right)$ and the gluon (**gl**) $\phi_{g(gl)}\left(=0/m_{gl}\right)$ due to the division-by-zero error/paradox generated by $m_{ph}=0kg$ and $m_{gl}=0kg$ (with photons and gluons possessing only relativistic masses thus having zero rest masses).

Important co-statement (and prediction) of ZEH-3 on the hypothetical graviton and the possible profound connections by "conjugated symmetry of masses" (CSM) between the known neutrinos and the known bosons plus the hypothetical graviton. However, ZEH-3 additionally co-states that $\phi_{g(ph)}$ and $\phi_{g(gl)}$ may also have very large values (corresponding to incredibly light photon and gluon, with incredibly small nzrm which may create the illusion of massless EPs possessing only relativistic masses/energies, possibly an illusion created by the lack of EMC in the case of both the photon and the gluon), so that these large values (of $\phi_{g(ph)}$ and $\phi_{g(gl)}$) may actually be the same with

$\phi_{g(en)}$, $\phi_{g(mn)}$ and $\phi_{g(tn)}$. More specifically and ambitiously, ZEH-3 additionally states that $\boxed{\phi_{g(ph)} > \phi_{g(gl)}}$ and that there also exists a incredibly light/massless graviton (**gr**) defined by $\phi_{g(gr)} > \phi_{g(ph)}\left(> \phi_{g(gl)}\right)$ so that:

$$\boxed{\phi_{g(gr)} = \phi_{g(en)}\left(>1.1\times10^{53}u\right)} \quad \textbf{(5a)}$$

$$\boxed{\phi_{g(ph)} = \phi_{g(mn)}\left(>6\times10^{47}u\right)} \quad \textbf{(5b)}$$

$$\boxed{\phi_{g(gl)} = \phi_{g(tn)}\left(>5.6\times10^{45}u\right)} \quad \textbf{(5c)}$$

Note that, in the case of gl-tn, ph-mn and gr-en pairs, ZEH cannot estimate the common/shared $\phi_{e(\text{gl/tn})}$, $\phi_{e(\text{ph/mn})}$ and $\phi_{e(\text{gr/en})}$ ratios, because the generic $\phi_g\phi_e q_{EP}^{\,2}$ product is nullified by $q_{EP} = 0C$ of gl(&tn), ph(&mn) and gr(&en).

Focusing on the electron, muon, tauon and their ZEH-predicted correspondent/conjugated (super-)heavy bosons. In a 3rd step, ZEH-3 states that W boson and the electron are form a conjugate boson-fermion pair with rest masses $\boxed{m_e = \left(c^2 - \sqrt{c^4 - \phi_{g(W/e)}\phi_{e(W/e)}q_e^{\,2}}\right)/\phi_{g(\text{W/e})}}$ and $\boxed{m_W = \left(c^2 + \sqrt{c^4 - \phi_{g(W/e)}\phi_{e(W/e)}q_e^{\,2}}\right)/\phi_{g(\text{W/e})}}$. The common term $\sqrt{c^4 - \phi_{g(W-e)}\phi_{e(W-e)}q_e^{\,2}}$ of both rest masses (m_e and m_W) disappears when summing $\boxed{m_e + m_W = 2c^2/\phi_{g(\text{W/e})}}$, from which their common/shared $\phi_{g(\text{W/e})}$ ratio can be reversely estimated as $\boxed{\phi_{g(\text{W/e})} = 2c^2/\left(m_e + m_W\right) \cong 1.25\times10^{42}u}$, which is relatively close to $\phi_{g(Zb)}\left(\cong 10^{42}u\right)$ and $\phi_{g(\text{Hb})}\left(\cong 8\times10^{41}u\right)$. The other $\phi_{e(\text{W/e})}$ ratio can be also reversely estimated from both m_W (or m_e) and $\phi_{g(\text{W/e})}$ as

$$\boxed{\phi_{e(\text{W/e})} = \frac{c^4 - \left(m_W\phi_{g(W/e)} - c^2\right)^2}{\phi_{g(W/e)}q_e^{\,2}}\left[= \frac{c^4 - \left(c^2 - m_e\phi_{g(W/e)}\right)^2}{\phi_{g(W/e)}q_e^{\,2}}\right] \cong 6.4\times10^{24}\,NmC^{-2}}$$

Furthermore, ZEH-3 additionally co-states that, because the muon (**m**) (with rest mass $m_m \cong 106MeV/c^2$) and tauon (**t**) (with rest mass $m_t \cong 1.78GeV/c^2$) are essentially 2 excited (charged) states of the electron, the W boson may also have two excited charged forms called here "W-mu" (**Wm**+/-) and "W-tau" (**Wt**+/-) correspondent to the muon and the tauon respectively, with larger rest masses than Wb $m_{Wm}\left(> m_W\right)$ and $m_{Wt}\left(> m_{Wm} > m_W\right)$ AND shared/common ratios $\phi_{g(Wm/m)}\left(< \phi_{g(W/e)}\right)$ (shared by both Wm and m) and $\phi_{g(Wt/t)}\left(< \phi_{g(Wm/m)} < \phi_{g(W/e)}\right)$. More specifically and exactly (similarly to the deduction/prediction of $\phi_{g(\text{W/e})\left(\cong 1.25\times10^{42}u\right)}$), ZEH-3 states the following equalities:

$$\boxed{m_{Wm} = m_W\cdot\left(m_m/m_e\right) \cong 16.6TeV/c^2\left(>> m_{Hb}\right)} \quad \textbf{(6a)}$$

$$\boxed{m_{Wt} = m_W\cdot\left(m_t/m_e\right) \cong 279.6TeV/c^2\left(>> m_{Hb}\right)} \quad \textbf{(6b)}$$

$$\boxed{\phi_{g(\text{W/m})} = 2c^2/\left(m_m + m_{Wm}\right) \cong 6.1\times10^{39}u} \quad \textbf{(6c)}$$

$$\boxed{\phi_{g(\text{W/t})} = 2c^2/\left(m_t + m_{Wt}\right) \cong 3.6\times10^{38}u} \quad \textbf{(6d)}$$

The other $\phi_{e(\text{W/m})}$ ratio can be also reversely estimated from both m_{Wm} (or m_m) and $\phi_{g(\text{W/m})}$ as

$$\boxed{\phi_{e(\text{W/m})} = \frac{c^4 - \left(m_{Wm}\phi_{g(W/m)} - c^2\right)^2}{\phi_{g(W/m)}q_e^{\,2}}\left[= \frac{c^4 - \left(c^2 - m_m\phi_{g(W/m)}\right)^2}{\phi_{g(W/m)}q_e^{\,2}}\right] \cong 1.3\times10^{27}\,NmC^{-2}}$$

The other $\phi_{e(\text{W/t})}$ ratio can be also reversely estimated from both m_{Wt} (or m_t) and $\phi_{g(\text{W/t})}$ as

$$\boxed{\phi_{e(\text{W/t})} = \frac{c^4 - \left(m_{Wt}\phi_{g(W/t)} - c^2\right)^2}{\phi_{g(W/t)}q_e^{\,2}}\left[= \frac{c^4 - \left(c^2 - m_t\phi_{g(W/t)}\right)^2}{\phi_{g(W/t)}q_e^{\,2}}\right] \cong 2.2\times10^{28}\,NmC^{-2}}$$

The ZEH-3-predicted super-heavy Wm and Wt bosons (which are much heavier than the Higgs boson) may possibly explain the mass of Hb (by a mechanism similar to the Higgs mechanism) but may also indicate/suggest the existence of a 4th generation of quarks (**4GQs**) even heavier than Hb: the search for new heavy 4GQs is still the subject of active research at the LHC today [URL1, URL2, URL3], even if all searches for 4GQs until present have failed; Sheldon Lee Glashow and James Bjorken predicted the existence of a 4th flavor of quark (which they called "charm") which allowed for a better description of the weak interaction and implied a mass formula that correctly reproduced the masses of the known mesons [URL]. However, the ZEH-3-predicted Wm and Wt are so heavy that they most probably would generate quarks significantly heavier than Hb (thus making them very improbable to be generated at LHC in the near or medium future).

Focusing on the three generations of quarks. **In a 4th step**, for dealing with the known quarks, we propose two ZEH-3 main variants (**a & b**), but also some secondary ZEH-3 variants (**c, d, e**):

(1) ZEH-3a which states that **ALL EPs organize in boson-fermion mass-conjugates** (as initially stated and previously applied on all known non-quark EPs) which may imply that each quark in part has its own correspondent boson mass-conjugate (named here "quark-boson", because its has the same fractional charge as its mass-conjugate quark); however, ZEH-3a doesn't allow to directly estimate the ϕ_g and ϕ_e ratios for each (quark-)boson-quark pair, because the true existence of these theoretical quark-bosons (and their rest masses) is uncertain: other authors have also considered the existence of quark-bosons (bosons with fractional electromagnetic charges) [URL1a, URL1b].

(2) ZEH-3b which states that **ALL EPs EXCEPT quarks organize in boson-fermion mass-conjugates** (as initially stated and previously applied on all known non-quark EPs): quarks with the same fractional charge however (which are aligned horizontally in the particles table of the Standard model), are stated by ZEH-3b to be actually conjugated in fermion-fermion (quark-quark) pairs like **up-charm quarks [uq-cq] pair (of conjugates)**, **down-strange quark [dq-sq] pair**, **top-"X_top" quark (tq-Xtq) pair** and **bottom-X_bottom quark (bq-Xbq) pair**, with X_top quark (with ±2/3e electromagnetic charge [**emc**]) and X_bottom quark (with ±1/3e emc) composing **the predicted 4th generation of quarks** (as also previously suggested/indicated/predicted by the ZEH-3 predicted "**Wm**" and "**Wt**" super-heavy bosons); ZEH-3b has the advantage to can directly estimate these common/shared ratios: $\phi_{g(u/cq)}$ & $\phi_{e(u/cq)}$ (shared by **up-charm quarks pair**) and $\phi_{g(d/sq)}$ & $\phi_{e(d/sq)}$ (shared by **down-strange quarks pair**); **for the up-charm quarks pair (of conjugates)** we have $\boxed{m_u + m_c = 2c^2/\phi_{g(u/cq)}}$, from which their common/shared $\phi_{g(u/cq)}$ ratio can be reversely estimated as $\boxed{\phi_{g(u/cq)} = 2c^2/\left(m_{uq}+m_{cq}\right) \cong 7.8\times10^{43}u}$: the other $\phi_{e(u/cq)}$ ratio can be also reversely estimated from both m_{cq} (or m_{uq}) and $\phi_{g(u/cq)}$ as

$$\boxed{\phi_{e(u/cq)} = \frac{c^4-\left(m_{cq}\phi_{g(u/cq)}-c^2\right)^2}{\phi_{g(u/cq)}\left(\tfrac{2}{3}q_e\right)^2}\left[=\frac{c^4-\left(c^2-m_{uq}\phi_{g(u/cq)}\right)^2}{\phi_{g(u/cq)}\left(\tfrac{2}{3}q_e\right)^2}\right] \cong 6.4\times10^{25}NmC^{-2}};$$

for the **down-strange quark pair (of conjugates)** we have $\boxed{m_d + m_s = 2c^2/\phi_{g(d/sq)}}$, from which their common/shared $\phi_{g(d/sq)}$ ratio can be reversely estimated as $\boxed{\phi_{g(d/sq)} = 2c^2/\left(m_{dq}+m_{sq}\right) \cong 10^{45}u}$: the other $\phi_{e(d/sq)}$ ratio can be also reversely estimated from both m_{dq} (or m_{sq}) and $\phi_{g(d/sq)}$ as

$$\boxed{\phi_{e(d/sq)} = \frac{c^4-\left(m_{sq}\phi_{g(d/sq)}-c^2\right)^2}{\phi_{g(d/sq)}\left(\tfrac{1}{3}q_e\right)^2}\left[=\frac{c^4-\left(c^2-m_{dq}\phi_{g(d/sq)}\right)^2}{\phi_{g(d/sq)}\left(\tfrac{1}{3}q_e\right)^2}\right] \cong 5.1\times10^{26}NmC^{-2}};$$

(3) ZEH-3c is a variant of ZEH-3 which combines ZEH-3a and ZEH-3b: more specifically, ZEH-3c states that only the two generation of quarks may be actually reciprocally conjugated in fermion-fermion (quark-quark) pairs like **up-charm quarks pair (of conjugates)**, **down-strange quark pair** (a statement similar to **ZEH-3b**); distinctively from ZEH-3b, ZEH-3c states that the 3rd generation of quarks may actually be conjugated with two unknown quark-bosons called "**top-boson**" (**Tb**) (with ±2/3e electromagnetic charge [**emc**], which conjugates to the top-quark) and "**bottom boson**" (**Bb**) (with ±1/3e emc, which conjugates to the bottom-quark);

(4) ZEH-3d is a variant of ZEH-3 (distinct from ZEH-3a) which deals in a specific manner with those EPs defined as excited states of other lighter EPs (with needing a 4th generation of quarks): more specifically, ZEH-3d states that the muon (**m**) and the tauon (**t**) (which are considered two distinct excited states of the same electron) could be actually reciprocal conjugates (thus not necessarily conjugated with other two [previously predicted] bosons [heavier than the W boson]: **Wm** and **Wt**), so that $\boxed{m_m + m_t = 2c^2/\phi_{g(m/t)}}$, from which their common/shared $\phi_{g(m/t)}$ ratio can be reversely estimated as $\boxed{\phi_{g(m/t)} = 2c^2/\left(m_m+m_t\right) \cong 5.36\times10^{43}u}$, which is approximately 15-20 times larger than $\phi_{g(Zb)}\left(\cong 10^{42}u\right)$ and $\phi_{g(Hb)}\left(\cong 8\times10^{41}u\right)$. The other $\phi_{e(m/t)}$ ratio can be also reversely estimated from both m_t (or m_m) and $\phi_{g(m/t)}$ as

$$\boxed{\phi_{e(m/t)} = \frac{c^4-\left(m_t\phi_{g(m/t)}-c^2\right)^2}{\phi_{g(m/t)}q_e^2}\left[=\frac{c^4-\left(c^2-m_m\phi_{g(m/t)}\right)^2}{\phi_{g(m/t)}q_e^2}\right] \cong 1.2\times10^{27}NmC^{-2}}.$$

Furthermore, ZEH-3d states that the 1st generation quarks (the up-quark [**uq**] and the down-quark [**dq**]) may be actually conjugated with two distinct quark-boson (the "**up-boson**" [**Ub**] with emc ±2/3e [conjugated to uq] and the "**down-boson**" [**Db**] with emc ±1/3e [conjugated to dq]) **AND** the other two quark generations (the charm-quark [**cq**]&top quarks [which are considered two distinct excited states of the same uq] and the strange-bottom quarks [which are considered two distinct excited states of the same dq]) may be actually reciprocal conjugates on horizontal so that $\boxed{m_{cq} + m_{tq} = 2c^2/\phi_{g(c/tq)}}$ (and $\boxed{m_{sq} + m_{bq} = 2c^2/\phi_{g(s/bq)}}$ respectively), from which their common/shared $\phi_{g(c/tq)}$ ratio (and

$\phi_{g(\text{s/bq})}$ ratio respectively) can be reversely estimated as $\boxed{\phi_{g(\text{c/tq})} = 2c^2 / \left(m_{cq} + m_{tq}\right) \cong 5.7\times10^{41}u}$ (and $\boxed{\phi_{g(\text{s/bq})} = 2c^2 / \left(m_{sq} + m_{bq}\right) \cong 2.3\times10^{43}u}$ respectively): the other $\phi_{e(\text{c/tq})}$ ratio can be also reversely estimated from both m_{tq} (or m_{cq}) and $\phi_{g(\text{c/tq})}$ as

$$\boxed{\phi_{e(\text{c/tq})} = \frac{c^4 - \left(m_{tq}\phi_{g(\text{c/tq})} - c^2\right)^2}{\phi_{g(\text{c/tq})}\left(\tfrac{2}{3}q_e\right)^2}\left[= \frac{c^4 - \left(c^2 - m_{cq}\phi_{g(\text{c/tq})}\right)^2}{\phi_{g(\text{c/tq})}\left(\tfrac{2}{3}q_e\right)^2}\right] \cong 3.6\times10^{28}\,NmC^{-2}};$$

the other $\phi_{e(\text{s/bq})}$ ratio can be also reversely estimated from both m_{bq} (or m_{sq}) and $\phi_{g(\text{s/bq})}$ as

$$\boxed{\phi_{e(\text{s/bq})} = \frac{c^4 - \left(m_{bq}\phi_{g(\text{s/bq})} - c^2\right)^2}{\phi_{g(\text{s/bq})}\left(\tfrac{1}{3}q_e\right)^2}\left[= \frac{c^4 - \left(c^2 - m_{sq}\phi_{g(\text{s/bq})}\right)^2}{\phi_{g(\text{s/bq})}\left(\tfrac{1}{3}q_e\right)^2}\right] \cong 1.05\times10^{28}\,NmC^{-2}}.$$

*

All the proposed pairs of EP mass-conjugates (as stated by ZEH-3a, ZEH-3b, ZEH-3c and ZEH-3d) are illustrated in the **next table (each with their specific assigned ϕ_g and ϕ_e ratios)**.

(Table 1)

Table 1. The pair of conjugated EPs predicted by ZEH (mainly by the sub-hypotheses ZEH-3a, ZEH-3b, ZEH-3c and ZEH-3d)

Boson (/corresponde nt conjugate boson of a known fermion)	**Fermion** (/corresponde nt conjugate fermion of a known boson)	Common/ shared ϕ_g ratio of a conjugated boson-fermion pair	Common/ shared ϕ_e ratio of a conjugated boson-fermion pair
Non-quark EPs as treated by ZEH-3a and ZEH-3b			
hypothetical graviton (**gr**) (spin-2 neutral boson, with color charge only)	electron neutrino (**en**)	$\phi_{g(gr)} = \phi_{g(en)}$ $\left(>1.1\times10^{53}u\right)$	?
photon (**ph**) (spin-1 neutral boson)	muon neutrino (**mn**)	$\phi_{g(ph)} = \phi_{g(mn)}$ $\left(>6\times10^{47}u\right)$	?
gluon (**gl**) (spin-1 neutral boson)	tauon neutrino (**tn**)	$\phi_{g(gl)} = \phi_{g(tn)}$ $\left(>5.6\times10^{45}u\right)$	?
Z boson (**Zb**) (spin-1 neutral boson)	"Z-fermion" (**Zf**) (predicted neutral massless ½-spin fermion)	$\phi_{g(Zb)}$ $\cong 10^{42}u$	?
Higgs boson (**Hb**) (spin-0/scalar neutral boson)	"Higgs-fermion" (**Hf**) (predicted neutral massless ½-spin fermion)	$\phi_{g(Hb)}$ $\cong 8\times10^{41}u$	?
W boson (**Wb**) (spin-1 charged boson)	electron (**e**)	$\phi_{g(\text{W/e})} \cong$ $1.25\times10^{42}u$	$\phi_{e(\text{W/e})} \cong$ $6.4\times10^{24}F^{-1}$
"W muonic-boson" (**Wm**) (predicted charged 0/1-spin boson) with $\boxed{E_{Wm} \cong 16.6TeV}$	muon (**m**)	$\phi_{g(\text{W/m})}$ $\cong 6.1\times10^{39}u$	$\phi_{e(\text{W/m})}$ $\cong 1.3\times10^{27}F^{-1}$
"W tauonic-boson" (**Wt**) (predicted charged 0/1-spin boson) with	tauon (**t**)	$\phi_{g(\text{W/t})}$ $\cong 3.6\times10^{38}u$	$\phi_{e(\text{W/t})}$ $\cong 2.2\times10^{28}F^{-1}$

$\boxed{E_{Wt} \cong 279.6 TeV}$			
Quarks (only) as treated by ZEH-3b			
up quark (**uq**)	charm quark (**cq**)	$\phi_{g\,(\mathrm{u/cq})} \cong 7.8\times10^{43}u$	$\phi_{\mathrm{e(u/cq)}} \cong 6.4\times10^{25}F^{-1}$
down quark (**dq**)	strange quark (**sq**)	$\phi_{g\,(\mathrm{d/sq})} \cong 10^{45}u$	$\phi_{\mathrm{e(d/sq)}} \cong 5.1\times10^{26}F^{-1}$
top quark (**tq**)	"X-top quark" (**Xtq**) (predicted ±2/3e quark from a hypothetical 4th generation of quarks)	?	?
bottom quark (**bq**)	"X-bottom quark" (**Xbq**) (predicted ±1/3e quark from a hypothetical 4th generation of quarks)	?	?
Quarks (only) as treated by ZEH-3c			
up quark (**uq**)	charm quark (**cq**)	$\phi_{g\,(\mathrm{u/cq})} \cong 7.8\times10^{43}u$	$\phi_{\mathrm{e(u/cq)}} \cong 6.4\times10^{25}F^{-1}$
down quark (**dq**)	strange quark (**sq**)	$\phi_{g\,(\mathrm{d/sq})} \cong 10^{45}u$	$\phi_{\mathrm{e(d/sq)}} \cong 5.1\times10^{26}F^{-1}$
"Top-boson" (**Tb**) (a predicted ±2/3e quark boson)	top quark (**tq**)	?	?
"Bottom-boson" (**Bb**) (a predicted ±1/3e quark boson)	bottom quark (**bq**)	?	?
The muon, tauon and quarks (only) as treated by ZEH-3d			
muon (**m**)	tauon (**t**)	$\phi_{g\,(\mathrm{m/t})} \cong 5.36\times10^{43}u$	$\phi_{\mathrm{e(m/t)}} \cong 1.2\times10^{27}F^{-1}$
"Up-boson" (**Ub**) (a predicted ±2/3e quark boson)	up quark (**uq**)	?	?
"Down-boson" (**Db**) (a predicted ±1/3e quark boson)	down quark (**dq**)	?	?
charm quark (**cq**)	top quark (**tq**)	$\phi_{g\,(\mathrm{c/tq})} \cong 5.7\times10^{41}u$	$\phi_{\mathrm{e(c/tq)}} \cong 3.6\times10^{28}F^{-1}$
strange quark (**sq**)	bottom quark (**bq**)	$\phi_{g\,(\mathrm{s/bq})} \cong 2.3\times10^{43}u$	$\phi_{\mathrm{e(s/bq)}} \cong 1.05\times10^{28}F^{-1}$

*

(**Table 2**) All the proposed pairs of EP-conjugates (as stated by ZEH-3a, ZEH-3b, ZEH-3c and ZEH-3d) are also illustrated in the **next table**: as it can be seen from this next table, ZEH-3 transforms the already "classical" 2D table of EPs (from the Standard model [**SM**] of particle physics) in a 3D structure/table in which EPs are grouped NOT ONLY in boson and fermion families/subfamilies, BUT they are also grouped and inter-related by an "underneath" relation of boson-fermion mass conjugation (or fermion-fermion mass conjugation), all based on the same simple semi-empirical quadratic equation proposed by ZEH.

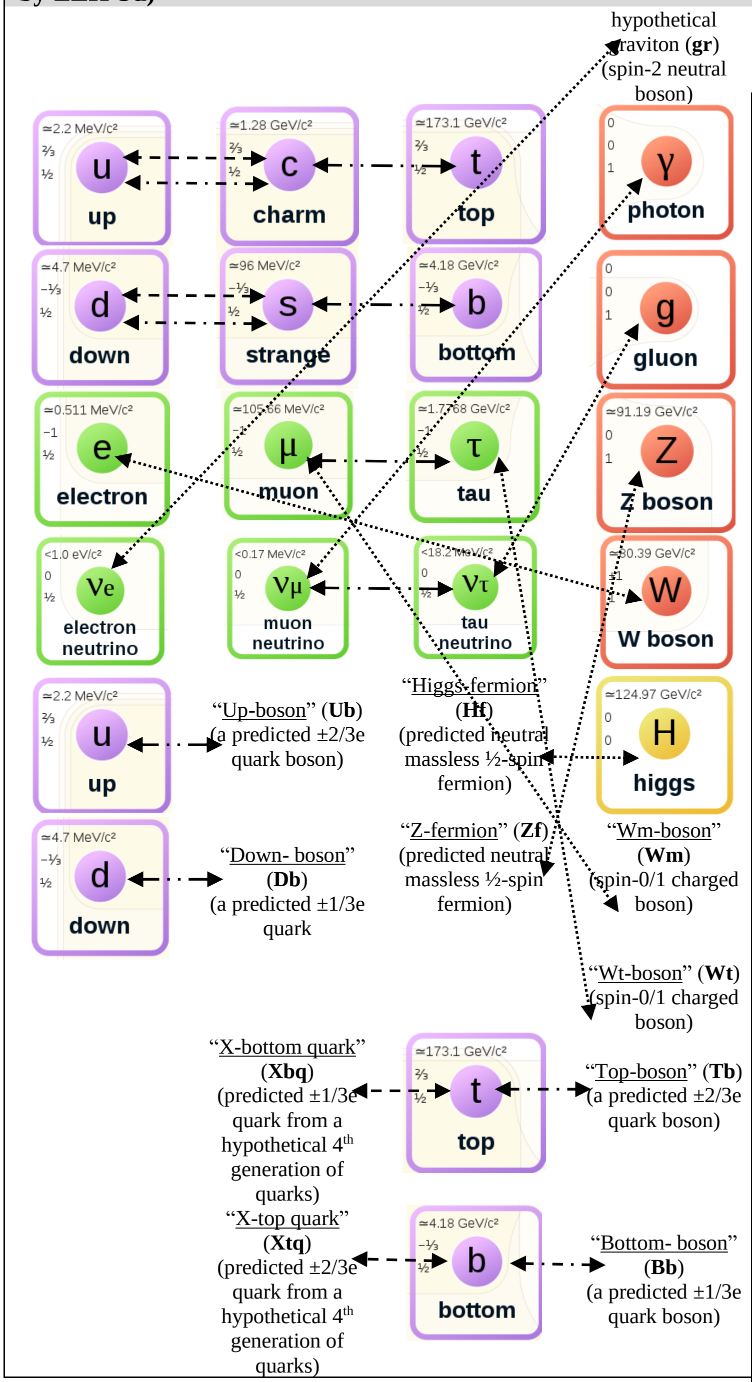
Table 2. The pairing of conjugated EPs predicted by ZEH and marked by interconnecting arrows (mainly by the sub-hypotheses ZEH-3a, ZEH-3b, ZEH-3c and ZEH-3d). Source of image extracts: https://en.wikipedia.org/wiki/File:Standard_Model_of_Elementary_Particles.svg

◄······► (marks each pair of conjugates stated by ZEH-3a, except quarks)

◄ – – ► (marks each pair of quark-conjugates stated by ZEH-3b)

◄·–·–·–·► (marks each pair of quark/boson-conjugates stated by ZEH-3c)

◄·—··—► (marks each pair of quark/boson-conjugates stated by ZEH-3d)



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ZEH's 4th co-statement (ZEH-4) and its implications. **ZEH-4** uses the minimum length/distance $r_{\min}\left(=\left|q_{EP}\right|\sqrt{Gk_e}/c^2 \cong 10^{-1}l_{Pl}\right)$ needed for any virtual particle-antiparticle pair (**VPAP**) to pop out from the vacuum at the first place (as stated and predicted by ZEH for all rest masses to be describable by real numbers with mass units) AND all the ZEH-3-predicted ϕ_g and ϕ_e ratios (briefly listed in the first table of this paper) to predict (**pr.**) the big G and Coulomb's constant k_e values at scales $r_{\min}\left(\cong 10^{-1}l_{Pl}\right)$ comparable to Planck scale as $G_{pr}=\phi_{g(pr)}r_{\min}$ and $k_{e(pr)}=\phi_{e(pr)}r_{\min}$ (**see the next table**)

(Table 3)

Table 3. The predicted big G values $G_{pr}=\phi_{g(pr)}r_{\min}$ and Coulomb's constant values $k_{e(pr)}=\phi_{e(pr)}r_{\min}$ for all pairs of conjugated EPs predicted by ZEH (mainly by the sub-hypotheses ZEH-3a, ZEH-3b, ZEH-3c and ZEH-3d)

Pair of conjugated EPs	Common/ shared ϕ_g and ϕ_e ratios	G_{pr} $\left(=\phi_{g(pr)}r_{\min}\right)$	$k_{e(pr)}$ $\left(=\phi_{e(pr)}r_{\min}\right)$
Non-quark EPs as treated by ZEH-3a and ZEH-3b			
hypothetical graviton (**gr**) & electron neutrino (**en**)	$\phi_{g(gr)}=\phi_{g(en)}$ $\left(>1.1\times10^{53}u\right)$?	$>2.1\times10^{27}G$	?
photon (**ph**) - muon neutrino (**mn**)	$\phi_{g(ph)}=\phi_{g(mn)}$ $\left(>6\times10^{47}u\right)$?	$>1.2\times10^{22}G$	?
gluon (**gl**) - tauon neutrino (**tn**)	$\phi_{g(gl)}=\phi_{g(tn)}$ $\left(>5.6\times10^{45}u\right)$?	$>1.2\times10^{20}G$	?
Z boson (**Zb**) & "Z-fermion" (**Zf**)	$\phi_{g(Zb)}$ $\cong 10^{42}u$	$\cong 2.1\times10^{16}G$	?
Higgs boson (**Hb**) & "Higgs-fermion" (**Hf**)	$\phi_{g(Hb)}$ $\cong 8\times10^{41}u$	$\cong 1.7\times10^{16}G$	?
W boson (**Wb**) & electron (**e**)	$\phi_{g(W/e)}\cong$ $1.25\times10^{42}u$ $\phi_{e(W/e)}\cong$ $6.4\times10^{24}F^{-1}$	$\cong 2.6\times10^{16}G$	$\cong 10^{-21}k_e$

“W muonic-boson” (**Wm**) & muon (**m**)	$\phi_{g(\mathrm{W/m})} \cong 6.1\times10^{39}u$ $\phi_{e(\mathrm{W/m})} \cong 1.3\times10^{27}F^{-1}$	$\cong 1.3\times10^{14}G$	$\cong 2\times10^{-19}k_e$
“W tauonic-boson” (**Wt**) & tauon (**t**)	$\phi_{g(\mathrm{W/t})} \cong 3.6\times10^{38}u$ $\phi_{e(\mathrm{W/t})} \cong 2.2\times10^{28}F^{-1}$	$\cong 7.5\times10^{12}G$	$\cong 3.4\times10^{-18}k_e$
Quarks (only) as treated by ZEH-3b and ZEH-3c			
up quark (**uq**) & charm quark (**cq**)	$\phi_{g(\mathrm{u/cq})} \cong 7.8\times10^{43}u$ $\phi_{e(\mathrm{u/cq})} \cong 6.4\times10^{25}F^{-1}$	$\cong 1.6\times10^{18}G$	$\cong 10^{-20}k_e$
down quark (**dq**) & strange quark (**sq**)	$\phi_{g(\mathrm{d/sq})} \cong 10^{45}u$ $\phi_{e(\mathrm{d/sq})} \cong 5.1\times10^{26}F^{-1}$	$\cong 2.1\times10^{19}G$	$\cong 7.9\times10^{-20}k_e$
The muon, tauon and quarks (only) as treated by ZEH-3d			
muon (**m**) & tauon (**t**)	$\phi_{g(\mathrm{m/t})} \cong 5.36\times10^{43}u$ $\phi_{e(\mathrm{m/t})} \cong 1.2\times10^{27}F^{-1}$	$\cong 1.1\times10^{18}G$	$\cong 1.9\times10^{-19}k_e$
charm quark (**cq**) & top quark (**tq**)	$\phi_{g(\mathrm{c/tq})} \cong 5.7\times10^{41}u$ $\phi_{e(\mathrm{c/tq})} \cong 3.6\times10^{28}F^{-1}$	$\cong 1.2\times10^{16}G$	$\cong 5.5\times10^{-18}k_e$
strange quark (**sq**) & bottom quark (**bq**)	$\phi_{g(\mathrm{s/bq})} \cong 2.3\times10^{43}u$ $\phi_{e(\mathrm{s/bq})} \cong 1.05\times10^{28}F^{-1}$	$\cong 4.7\times10^{17}G$	$\cong 1.6\times10^{-18}k_e$

*

Interpretation. From the previous table, one can easily remark that ZEH predicts a big G which may increase (when decreasing the length scale of measurement up to values $G_{pr}\left(=\phi_{g(\mathrm{en})}r_{\min}\right) > 2.1\times10^{27}G$ at $r_{\min}\left(\cong 10^{-1}l_{Pl}\right)$ length scales (comparable to Planck scale): concomitantly (and accordingly to the same table) and interestingly, ZEH predicts that Coulomb's constant k_e may drop down to values $k_{e(pr)}\left(=\phi_{e(\mathrm{W/m})}r_{\min}\right)\cong 10^{-21}k_e$ at the same length scales close to $r_{\min}\left(\cong 10^{-1}l_{Pl}\right)$.

Important observation. For the electron rest mass $\left(m_e\right)$ at macroscopic scales $r\left(>> r_{\min}\right)$ (for which $G_{pr}\cong G$) for example, the $\frac{k_e q_e^2}{G m_e^2}\left(\cong 4.2\times10^{42}\right)$ dimensionless ratio reaches almost 43 orders of magnitude (in favor of the $k_e q_e^2$ numerator): interestingly, at Planck (**Pl**) scales big G may grow by at least 27 orders of magnitude (up to $G_{\mathrm{Pl}}\cong 10^{27}G$) and k_e may drop by at least 21 orders of magnitude (down to $k_{e(Pl)}\cong 10^{-21}k_e$) which may bring the ratio $\frac{k_{e(\mathrm{Pl})}q_e^2}{G_{\mathrm{Pl}}m_e^2}$ very close to 1; the Coulomb's constant k_e is currently defined as a function of the running coupling constant of the electromagnetic field (**EMF**) $\alpha\left(E\right)=\alpha_0/\left(1-\alpha_0 f(\mathrm{E})\right)$[5] so that $k_e(\mathrm{E})=\alpha(\mathrm{E})\hbar c/q_e^2$: the currently known $\alpha\left(E\right)$ (which is currently predicted by its leading log approximation [**LLA**] to can only grow when approaching Planck energy/length scales E_{Pl}) is thus alternatively predicted by ZEH to actually slightly grow (as described by LLA) at first (when decreasing the length scale) but then to drop significantly down to $\alpha_{Pl}=\alpha\left(E_{Pl}\right)$ so that $k_{e(Pl)}=\alpha_{Pl}\hbar c/q_e^2\left(\cong 10^{-21}k_e\right)$ which is equivalent to $\boxed{\alpha_{Pl}\cong 10^{-21}\alpha_0}$ (which tends to the value of the gravitational coupling constant $\alpha_G\cong 10^{-43}\alpha_0\cong 10^{-45}$) and indicates EMF to probably possess asymptotic freedom (like the strong nuclear field was already proved to have).

ZEH-4 main statement. Based on the previous observation, ZEH-4 states (and predicts) that the gravitational field (**GF**) progressively grows in strength when approaching the $r_{\min}\left(\cong 10^{-1}l_{Pl}\right)$ length-scale (up to $G_{\mathrm{Pl}}\cong 10^{27}G$) and the electromagnetic field (**EMF**) slightly grows and then drops in strength (when approaching the same $r_{\min}$ length-scale) up to $k_{e(Pl)}\cong 10^{-21}k_e$ reaching the following equality at $r_{\min}$ scales:

$$\boxed{G_{Pl}m_e^2\cong k_{e(Pl)}q_e^2\left(\cong m_e c^2 r_{\min}\right)} \quad (7)$$

As seen from the previous equation, ZEH-4 is essentially a fundamental principle of electro-gravitational strength balance/symmetry at Planck scales, a principle which allows (as

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[5] the leading log approximation of $\alpha\left(E\right)$, which is only valid for large energy scales $E >> E_e$, with $f(\mathrm{E})=\ln\left[\left(E/E_e\right)^{2/(3\pi)}\right]$

a sine-qua-non condition added to Heisenberg's uncertainty principle [HUP]) the existence of virtual particle-antiparticle pairs (VPAPs) from the first place.

*

Deduction of ϕ_g specific to charged leptons (cl) plus ϕ_g assigned to the W boson (Wb). At least in the case of all charged leptonic EPs (**clEPs**), the previous **Eq.7** implies that $\phi_g m_{clEP}{}^2 \cong \phi_e q_e{}^2$, so that **Eq.2a** simplifies to:

$$\boxed{2\phi_{g(clEP)} m_{clEP}{}^2 - \left(2c^2\right) m_{clEP} = 0} \quad \textbf{(8a)}$$

resulting (see below)

$$\boxed{\phi_{g(clEP)} \underset{ZEH-4}{\overset{estim.}{=}} \frac{c^2}{m_{clEP}}} \quad \textbf{(8b)}$$

ZEH uses **Eq.8b** to alternatively estimate the specific $\phi_{g(clEP)}$ of all known clEPs (with known non-zero rest masses [**nzrm**]) and of the W boson (**Wb**) (by extrapolation) with nzrm m_{Wb}, such as:

$$\boxed{\phi_{g(e)} = c^2 / m_e \left(\cong 9.87 \times 10^{46} u\right)} \quad \textbf{(9a)}$$

$$\boxed{\phi_{g(m)} = c^2 / m_m \left(\cong 4.77 \times 10^{44} u\right)} \quad \textbf{(9b)}$$

$$\boxed{\phi_{g(t)} = c^2 / m_t \left(\cong 2.84 \times 10^{43} u\right)} \quad \textbf{(9c)}$$

$$\boxed{\phi_{g(Wb)} = c^2 / m_{Wb} \left(\cong 6.27 \times 10^{41} u\right)} \quad \textbf{(9d)}$$

Deduction of $\phi_{g(qu)}$ specific to quarks (qu). For all quarks with nzEMC $\left|q_{qu}\right| = \frac{2}{3}\left|q_e\right|$ and generic nzrm m_{qu}, the factor $k_{e(Pl)} q_{EP}{}^2 \left(= G_{Pl} m_{EP}{}^2\right)$ becomes $\frac{4}{9} k_e q_e{}^2 \left(= \frac{4}{9} G_{Pl} m_{qu}{}^2\right)$ which implies $\frac{4}{9}\phi_e q_e{}^2 \left(= \frac{4}{9}\phi_{g(qu)} m_{qu}{}^2\right)$ and may be applied to simplify **Eq.2a** resulting:

$$\boxed{\phi_{g(qu)} m_{qu}{}^2 - \left(2c^2\right) m_{qu} + \tfrac{4}{9}\phi_{g(qu)} m_{qu}{}^2 = 0} \quad \textbf{(10a)}$$

resulting (see below)

$$\boxed{\phi_{g(qu)} \underset{ZEH-4}{\overset{estim.}{=}} \frac{2c^2}{\frac{13}{9} m_{qu}}} \quad \textbf{(10b)}$$

ZEH uses **Eq.10b** to estimate the specific $\phi_{g(qu)}$ of all known quarks with nzEMC $\left|q_{qu}\right| = \frac{2}{3}\left|q_e\right|$ (the up-quark [**uq**] with nzrm m_{uq}, the charm-quark [**cq**] with nzrm m_{cq} and the top-quark with nzrm m_{tq}) such as:

$$\boxed{\phi_{g(uq)} = \frac{2c^2}{\frac{13}{9} m_{uq}} \left(\cong 3 \times 10^{46} u\right)} \quad \textbf{(11a)}$$

$$\boxed{\phi_{g(cq)} = \frac{2c^2}{\frac{13}{9} m_{cq}} \left(\cong 5.4 \times 10^{43} u\right)} \quad \textbf{(11b)}$$

$$\boxed{\phi_{g(tq)} = \frac{2c^2}{\frac{13}{9} m_{cq}} \left(\cong 4 \times 10^{41} u\right)} \quad \textbf{(11c)}$$

For all quarks with nzEMC $\left|q_{qu}\right| = \frac{1}{3}\left|q_e\right|$ and generic nzrm m_{qu}, the factor $k_{e(Pl)} q_{EP}{}^2 \left(= G_{Pl} m_{EP}{}^2\right)$ becomes $\frac{1}{9} k_{e(Pl)} q_e{}^2 \left(= \frac{1}{9} G_{Pl} m_{qu}{}^2\right)$ which implies $\frac{1}{9}\phi_e q_e{}^2 \left(= \frac{1}{9}\phi_{g(qu)} m_{qu}{}^2\right)$ and may be applied to simplify **Eq.2a** resulting:

$$\boxed{\phi_{g(qu)} m_{qu}{}^2 - \left(2c^2\right) m_{qu} + \tfrac{1}{9}\phi_{g(qu)} m_{qu}{}^2 = 0} \quad \textbf{(12a)}$$

resulting (see below)

$$\boxed{\phi_{g(qu)} \underset{ZEH-4}{\overset{estim.}{=}} \frac{2c^2}{\frac{10}{9} m_{qu}} = \frac{c^2}{\frac{5}{9} m_{qu}}} \quad \textbf{(12b)}$$

ZEH uses **Eq.12b** to estimate the specific $\phi_{g(qu)}$ of all known quarks with nzEMC $\left|q_{qu}\right| = \frac{1}{3}\left|q_e\right|$ (the down-quark [**dq**] with nzrm m_{dq}, the strange-quark [**sq**] with nzrm m_{sq} and the bottom-quark with nzrm m_{bq}) such as:

$$\boxed{\phi_{g(dq)} = \frac{2c^2}{\frac{10}{9} m_{dq}} \left(\cong 1.9 \times 10^{46} u\right)} \quad \textbf{(13a)}$$

$$\boxed{\phi_{g(sq)} = \frac{2c^2}{\frac{10}{9} m_{sq}} \left(\cong 9.1 \times 10^{44} u\right)} \quad \textbf{(13b)}$$

$$\boxed{\phi_{g(bq)} = \frac{2c^2}{\frac{10}{9} m_{bq}} \left(\cong 2.2 \times 10^{43} u\right)} \quad \textbf{(13c)}$$

*

ZEH's 5th co-statement (ZEH-4) and its implications. **ZEH-5** uses the same minimum length/distance $\boxed{r_{\min}\left(= \left|q_{EP}\right|\sqrt{Gk_e} / c^2 \cong 10^{-1} l_{Pl}\right)}$ needed for any virtual particle-antiparticle pair (**VPAP**) to pop out from the vacuum at the first place (as stated and predicted by ZEH for all rest masses to be describable by real numbers with mass units) to predict a series of practical (**pr.**) radii $\left(r_{pr}\right)$ for all known EPs and a finite maximum allowed massic/energetic density in our universe (**OU**).

The main statement of ZEH-5. For big G values to grow progressively with a decreasing length scale r_{pr}, ZEH-5 proposes/conjectures that BOTH the very large (but finite!)

maximum $G_{\max} = G_{Pl}\left(>2.1\times10^{27}G\right)$ and very small (but finite!) $r_{\min}\left(\cong 10^{-1}l_{Pl}\right)$ bijectively correspond only to the electron neutrino (**en**) (with very small BUT finite rest mass $m_{en} < 1eV/c^2$) which thus generates **a conjectured maximum (large but finite!) allowed (3D spherical) massic density in our universe (OU) identified with the massic density of en (which is predicted as significantly smaller than Planck density** $\rho_{Pl} = m_{Pl}/l_{Pl}^3 \cong 10^{96} kg\,m^{-3}$):

$$\boxed{\rho_{OU(\max)} = \rho_{en}\left(\cong \frac{m_{en}}{4\pi/3\; r_{\min}^3}\right) > 1.6\times10^{71} kg\,m^{-3}}$$

Furthermore, ZEH-5 ambitiously (and additionally) conjectures that the pre-Big-Bang singularity (pBBS) was NOT infinitely dense (thus wasn't a true gravitational singularity with infinite density!) but had a large-but-finite density ρ_{pBBS} **equal to** $\rho_{en}\left(>1.6\times10^{71} kg\,m^{-3}\right)$ **OR in the** $\left[\rho_{en},\rho_{Pl}\right]$ **closed interval, thus being a quasi-singularity with** $\boxed{\rho_{pBBS} = \rho_{OU(\max)}}$ **or** $\boxed{\rho_{pBBS} \in \left[\rho_{en},\rho_{Pl}\right]}$ **with all EPs being redefined as remnant "crocks" of this pBBS and sharing approximately the same unique density** $\boxed{\rho_{EP} \cong \rho_{pBBS}\left(=\rho_{OU(\max)}\right)}$ **(ZEH's unique-density conjecture [ZEH-UDC]).**

Based on the previously defined ZEH-UDC, ZEH-5 also proposes a simple formula for calculating the practical radii $r_{pr(EP)}$ **of any known type of known/unknown EP with non-zero rest mass**:

$$\boxed{r_{pr(EP)} \overset{>}{\cong} r_{\min}\sqrt[3]{m_{EP}/m_{en}}} \quad \textbf{(14)}$$

For example, the previously formula predicts that the Higgs boson (**Hb**) has a practical radius with a lower bound defined by $\boxed{r_{pr(Hb)} \cong r_{\min}\sqrt[3]{m_{Hb}/m_{en}} \cong 5\times10^3 r_{\min}}$, with all the other known/unknown EPs with non-zero rest masses smaller than m_{Hb} having their practical radii approximately in the closed interval $\left[r_{\min}, 5\times10^3 r_{\min}\right]$

ZEH-5 also states that known/unknown EPs with non-zero rest masses larger than m_{en} and practical radii larger than $r_{\min}$ correspond to smaller big G values $G_{EP} < G_{\max}\left(=G_{Pl}\right)$: more specifically, ZEH-5 actually generalizes ZEH-4 for any EP my stating that:

$$\boxed{G_{EP}m_{EP}^{\;2} \cong 2m_{EP}c^2 r_{\text{pr(EP)}}} \quad \text{(for neutral EPs) } \textbf{(15a)}$$

and (**see below**)

$$\boxed{G_{EP}m_{EP}^{\;2} \cong k_{e(\text{EP})}q_{EP}^{\;2}\left(\cong m_{EP}c^2 r_{pr(\text{EP})}\right)} \quad \text{(for charged EPs)}$$

(**15b**)

Based on the previous two equations, the big G values corresponding to each practical radii in part (of each type of EP in part) can be reversely deduced as:

$$\boxed{G_{EP} \cong \frac{2c^2}{m_{EP}} r_{\text{pr(EP)}} \cong \frac{2c^2 r_{\min}}{m_{EP}}\sqrt[3]{\frac{m_{EP}}{m_{en}}}} \quad \text{(for neutral EPs) } \textbf{(16a)}$$

and (**see below**)

$$\boxed{G_{EP} \cong \frac{c^2}{m_{EP}} r_{\text{pr(EP)}} \cong \frac{c^2 r_{\min}}{m_{EP}}\sqrt[3]{\frac{m_{EP}}{m_{en}}}} \quad \text{(for charged EPs) } \textbf{(16b)}$$

The growth of big G (which is predicted by ZEH to be inverse proportional to the length scale). To illustrate the growth of G_{EP} with the decrease in the length scale measured by $r_{\text{pr(EP)}}$ ZEH-5 proposes the double-logarithmic ratio

$$\boxed{f_{EP} \cong \log_{10}\left(\frac{\log_{10}\left(G_{EP}/G\right)}{r_{pr(EP)}/r_{\min}}\right)}$$

which is graphed next.

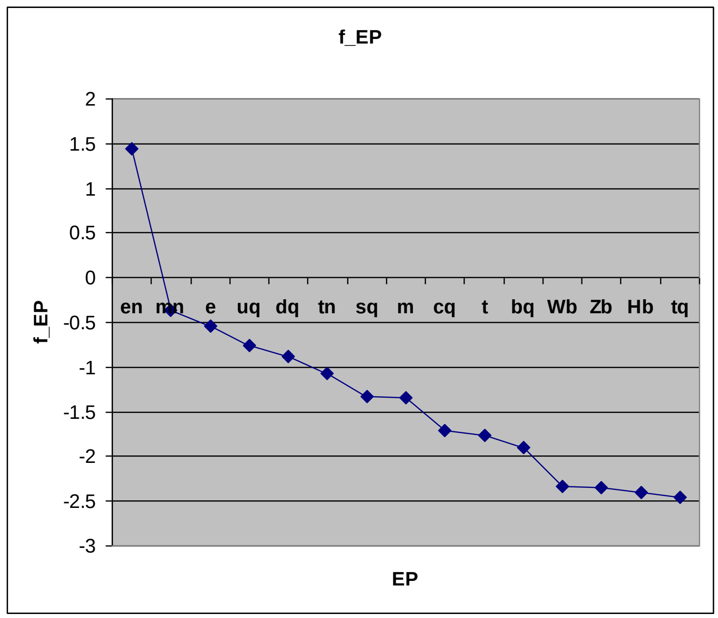

Figure 1. The variation of f_{EP} **with** $r_{pr(EP)}$ **which illustrates the increase of big G** $\left(G_{EP}\right)$ **values when the practical radius** $r_{pr(EP)}$ **(of each EP type in part) decreases, with all known EPs (with non-zero rest masses) being arranged in the ascending order of their** $r_{pr(EP)}$ **values (from left to right). The rhombic blue points from this graph (indirectly) correspond to each** G_{EP} **value (assigned to each type of EP) and the segments between each any two adjacent points (indirectly) correspond to each** $\phi_{g(EP)}$ **(assigned to the EP that corresponds to the left rhombic point of each segment in part).**

**

Final conclusions of this paper. What distinguishes ZEH is actually the contrast between its simplicity and the richness/diversity of explanations, correlations and predictions it offers. The author of this paper resonates to Dirac's vision on the importance of mathematical beauty in physical equations: "*The research worker, in his efforts to express the fundamental laws of Nature in mathematical form, should strive mainly for mathematical beauty […]It often happens that the requirements and beauty are the same, but where they clash the latter must take precedence.*" [URL]; "*A theory with mathematical beauty is more likely to be correct than an ugly one that fits some experimental data"* (as he claimed in 1970 when referring to the renormalization of quantum electrodynamics which was Dirac's paradigm of a mathematically "ugly" theory) [URL].

Zero is not only a number, but the symbol of both Nothingness and Everythingness (because all positive and negative numbers can be regarded as "born" in pairs from the same Zero to which they are symmetrical): furthermore, zero not only plays an essential central role in mathematics, but it also has a central role in physics and is a fundamental link between these two sciences, in the context of a possibly valid zero-energy universe theory (**ZEUT**).

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