On a possible logarithmic connection between Einstein's constant and the fine-structure constant, in relation to a zero-energy hypothesis

Abstract

This paper brings into attention *a possible logarithmic connection between Einstein's constant and the fine-structure constant*, based on a hypothetical electro-gravitational resistivity of vacuum: we also propose *a zero-energy hypothesis* (**ZEH**) which predicts a general formula for all the rest masses of all elementary particles from Standard model, also indicating 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 elementary particles have real number values (with mass units) instead of complex/imaginary number values (as predicted by the unique equation proposed by ZEH).

1. Introduction

Add something for understanding the basic idea of the paper with respect to current notion of unification of gravity and other forces.

2. Motivating points

Add the motivating points with respect to the inadequacy of current notion of unification of gravity and other forces.

3. Observations

3.1 First observation

Each of all known electromagnetically-charged elementary particles (**CEP**) in the Standard model has a non-zero rest energy which, in turn, is always associated with non-zero spacetime curvature (gravity) as implied by General relativity. Furthermore, because the electron (with elementary electromagnetic charge $-|e|$, rest mass m_p and rest energy $E_e = m_e c^2$ is the lightest known CEP with the largest known (absolute) charge-to-(rest)energy ratio in nature $\phi_{\max} = |e| / E_e$, thus *electromagnetic charge cannot exist and cannot manifest without a minimum degree of spacetime curvature indirectly measured by almost an infinitesimal gravitational coupling constant*,

$$\kappa E_e^2 \cong 1.3919 \times 10^{-69} \text{ kg m}^3\text{s}^{-2} \tag{1}$$

where $\kappa = 8\pi G / c^4$ = Einstein's constant.

Please explain the applications of κE_e^2. Could not find its role in the following sections.

3.2 Second observation

There is a simple logarithmic function which appears to relate both κ and $\phi_{\max}$ to the fine-structure constant at rest $\alpha_0 = k_e q_e^2 / (\hbar c) \cong (137^{-1})$ which is the *asymptotical minimum* at rest of the electromagnetic running coupling constant $\alpha(E) = \alpha_0 / (1 - \alpha_0 f(\text{E}))$ [1]: Please explain what k_e is and its expression.

$$\alpha_0 \overset{99.92\%}{\cong} \left[\log_2\left(\kappa^{-1} k_e \phi_{\max}^2\right)\right]^{-1} \cong 136.93^{-1} \quad \textbf{(1)}$$

α_0 may be directly related to $\left[\log_2\left(\kappa^{-1} k_e \phi_{\max}{}^2\right)\right]^{-1}$ with the following numbered arguments and explanations:

1) If the very *large dimensionless physical constants* (**DPCs**) (which are gravity-related in general, like $\kappa^{-1} k_e \phi_{\max} \cong 10^{41}$ for example) are deeply related with the small DPCs (usually close to 1 and related to quantum mechanics, like α_0 for example), by any (yet unknown) mathematical function, then a *logarithmic function* (**LF**) would be the simplest (and thus the most natural) candidate solution of connecting these large and small DPCs, as other authors also considered in the past [1,2]. Furthermore, even if it is not the case of such a logarithmical connection, possible LFs (connecting those DPCs) would still have to be ruled out first.
2) A direct logarithmic relation between an electromagnetic minimum of (α_0) and an 'electro-gravitational' maximum of $\phi_{\max}$ is quite intuitive;
3) $\kappa^{-1} \cong 4.815613 \times 10^{42}$ N which is relatively close to the Planck force $F_{Pl} = c^4 / G \cong 1.2103 \times 10^{44}$ N may be interpreted as a *global average "tension" of the spacetime fabric (as also interpreted by other authors* [1] *which strongly opposes to any spacetime curvature (**SC**) induced by any source of energy (including electromagnetic and/or gravitational energy tensors)*: because of this resistance to any induced SC (by any rest energy and/or movement of any bosonic or fermionic EP), κ^{-1} is identified with the approximate value at rest of an (energy/length-)scale-dependent *electro-gravitational resistivity of vacuum* (**EGRV**) represented by $R(E)$ with an asymptotic (please explain the meaning of asymptotic) maximum value at rest $R_0 = \dfrac{2^{1/\alpha_0}}{k_e \phi_{\max}} \cong 10^{43}\text{N}$ estimated to exactly.
4) Correspond to the asymptotic minimum α_0, so that $\alpha_0 = \left[\log_2\left(R_0 k_e \phi_{\max}^2\right)\right]^{-1}$. EGRV (measured by $R(E)$ and R_0 at rest) may be considered a truly fundamental parameter of spacetime with both c and G being actually determined by $R(E)$ and thus being indirect measures of EGRV. Another argument for α_0 measuring EGRV (which α_0 is alternatively defined as the probability of a real electron to emit or absorb a real photon) is that EGRV actually opposes to the photon emission process, in the sense that, for any real EP to emit a real photon, that photon first needs to overcome EGRV.
5) EGRV is very plausibly determined by the short-lived *virtual particle-antiparticle pairs* (**VPAPs**) emerging from the vacuum, which VPAPs interact with both photons and gravitational waves plausibly limiting their speed to a common maximum speed-limit for both speed of gravity and speed of light in

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

vacuum. Charged EPs (composing charged VPAPs) interact much more strongly with photons than neutral EPs (composing neutral VPAPs) so that $R(E)$ may actually depend on (and vary with) the ratio between the volumic concentrations of charged and neutral virtual EPs at various length scales of vacuum.

6) By replacing $k_e\phi_{\max}^2$ with its equivalent $\alpha_0\hbar c / {E_e}^2$, α_0 and R_0 become related by a special type of exponential equation such as:

$$\left(\frac{1}{\alpha_0}\right)2^{1/\alpha_0} \cong \frac{R_0\hbar c}{{E_e}^2} \tag{2}$$

7) Based on the previous equality, α_0 may be also considered as an indirect measure of EGRV and inversely redefined as the unique positive solution w of the exponential equation $(1/\mathrm{w})2^{1/\mathrm{w}} = C$, with

$$C \cong \frac{R_0\hbar c}{{E_e}^2} \cong \frac{\kappa^{-1}\hbar c}{{E_e}^2}$$ (number)

Is R_0 equals to κ^{-1}?

8) This equation can be solved by using the *Lambert function* only after converting it to its natural-base (e) variant $(\ln(2)/\mathrm{w})e^{\ln(2)/\mathrm{w}} = C\ln(2)$ so that:

$$\alpha_0 = \frac{\ln(2)}{W(C\ln(2))} \tag{3}$$

9) **This section is a very complicated to decide. Needs other supporting references with possible explanation, applications or experimental set ups.** By considering $\hbar$, E_e and c all to be scale-invariant, $R(E)$ *can be generalized and* $\alpha(E)$ *can be redefined as a function of this generalized* $R(E)$ *such as:*

$$R(E) \cong \frac{1}{2^{\mathrm{f(E)}}}\left[R_0 - \frac{R_0 f(\mathrm{E}}{\log_2(C)}\right]$$ (only **number. No alphabets**)

$$\alpha(E) = \frac{\ln(2)}{W\left(\ln(2)R(\mathrm{E})\hbar c / {E_e}^2\right)} \cong \frac{\alpha_0}{(1-\alpha_0 f(\mathrm{E}))}$$ (only **number. No alphabets**)

Please add a table with graph for $\alpha(E)$ with various values.

10) **This section is a very complicated to decide. Needs other supporting references with possible explanation, applications or experimental set ups.** A predicted quantum big G $G_q(E)$ (which also varies with energy scale E) can be also derived from the same $R(E)$, also implying that big G may actually be a function of both the speed of gravity v_g and EGRV, in such a way,

$$G_q(E) \cong \frac{c^4}{8\pi R(E)} \cong \frac{v_g{}^4}{8\pi R(E)} \tag{5}$$

This equation needs correction, with respect to $c = v_g$ or $R_0 = R(E)$.

Please add a table with graph for $\alpha(E)$ with various values.

From the previous relation, one may easily note that any subtle variation of v_g and/or $R(E)$ may produce a slight variation of big G numerical value: this fact may actually explain the apparently paradoxal divergence (with deviations up to $\pm 1\%$) of big G experimental values despite the technical advances in the design of the modern experiments.

4. A zero-energy hypothesis (ZEH)

We also propose *a zero-energy hypothesis* (**ZEH**) applied on any virtual particle-antiparticle pair (**VPAP**) popping out from the quantum vacuum at hypothetical length scales comparable to Planck scale. ZEH can be regarded as an extension of the notorious *zero-energy universe hypothesis* first proposed by the theoretical physicist Pascual Jordan. 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 $E_q = -k_e |q_{EP}|^2 / r$, *ZEH specifically states that*:

$$2E_{EP} + E_g + E_q = 0$$ (only **number. No alphabets**)

Defining the ratios $\phi_g = G / r$ and $\phi_e = k_e / r$ the previous equation is equivalent to the following simple quadratic equation with unknown $x = m_{EP}$:

$$\phi_g x^2 - \left(2c^2\right)x + \phi_e q_{EP}{}^2 = 0$$ (only **number. No alphabets**)

The previous equation is easily solvable and has two possible solutions which are both positive reals if $c^4 \geq \phi_g \phi_e q_{EP}{}^2 \geq 0$:

$$m_{EP} = \frac{c^2 \pm \sqrt{c^4 - \phi_g \phi_e q_{EP}{}^2}}{\phi_g}$$ (only **number. No alphabets**)

The realness condition $c^4 \geq \phi_g \phi_e q_{EP}{}^2 \geq 0$ implies the existence of a minimum distance between any two EPs (composing the same VPAP) $r_{\min} = q_{EP}\sqrt{Gk_e} / c^2 \cong 10^{-1} l_{Pl}$ (for $q_{EP} \cong e$ and with l_{Pl} being the Planck length): obviously, for distances lower than $r_{\min}$ the previous equation has only imaginary solutions $x = m_{EP}$ 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 variable with the energy/length scale and currently defined as a function of $\alpha(E)$ such as $k_e(E)=\alpha(E)\hbar c/e^2$, $r_{\min}$ can be generalized as $r_{\min}(E)=(q_{EP}/\mathrm{e})\sqrt{G\alpha(E)\hbar c}/c^2$ (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 $r_{\min}(E)$ values so that they are not detailed this paper.

Both generic $x=m_{EP}$ solutions of the previous equation **6b** indicate that, *because* m_{EP} *has discrete values only,* ϕ_G *(and* E_g *implicitly) and* ϕ_e *(and* E_q *implicitly) should all have discrete values only*. More interestingly, for neutral EPs (**NEPs**) with $q_{EP}=0$ (which implies $\phi_g\phi_e q_{EP}{}^2=0$) and $r\geq r_{\min}(>0m)$, $x=m_{EP}$ solutions may take *both*:

(**1**) Non-zero positive values $m_{EP}=2c^2/\phi_g(>0)$ (like in the case of all three types of neutrinos, the Z boson and the Higgs boson) AND

(**2**) zero values $m_{EP}=\left(c^2-\sqrt{c^4}\right)/\phi_g=0$ (like in the case of the gluon and the photon which both have zero rest mass $m_{EP}(=0\text{ kg})$ and are assigned only relativistic mass/energy by the Standard model).

In a first step and defining the unit of measure of $\phi_g\left(=2c^2/m_{NEP}\right)$ as $u=m^2kg^{-1}s^{-2}$, ZEH directly estimates ϕ_g for the Z boson (**Zb**) and Higgs boson (**Hb**) (with both Zb and Hb having non-zero rest energies) such as $\phi_{g(Zb)}\cong10^{42}u$ and $\phi_{g(Hb)}\cong8\times10^{41}u$. Based on the previously defined $r_{\min}\left(\cong10^{-1}l_{Pl}\right)$, we then obtain $G_{Zb(\min)}\left(=\phi_{g(Zb)}r_{\min}\right)\cong G_{Hb(\min)}\left(=\phi_{g(Hb)}r_{\min}\right)\cong2\times10^{16}G$: these huge predicted lower bounds for big G values at Planck scales indicate that E_g *may reach the same magnitude as* E_q $\left(E_g\cong E_q\Leftrightarrow\phi_g m_{EP}{}^2\cong\phi_e q_{EP}{}^2\right)$ *at Planck scales* and also suggest that $R(E)$ *(thus* $G_q(E)$ *and* $\alpha(E)$) *may actually take discrete values only*.

In a second step, ZEH estimates the lower bounds of ϕ_g for all known three neutrinos, as deducted from the currently estimated upper bounds of the non-zero rest energies of all three known types of neutrino: the electron neutrino (**en**) with $E_{en}<1eV$, the muon neutrino (**mn**) with $E_{mn}<0.17MeV$ and the tau neutrino (**tn**) with $m_{mn}<18.2MeV$: $\phi_{g(en)}>_{\cong}10^{53}u$, $\phi_{g(mn)}>_{\cong}6\times10^{47}u$ and $\phi_{g(tn)}>_{\cong}6\times10^{45}u$, with $\phi_{g(en)}$ being assigned a very large big G lower bound $G_{en(\min)}\left(=\phi_{g(en)}r_{\min}\right)\cong2\times10^{28}G$ thus strengthening the previously introduced (sub-)hypothesis $\phi_g m_{EP}{}^2\cong\phi_e q_{EP}{}^2$ at Planck scales.

Please explain…
If it is supposed that, lower the mass of a particle, higher the value of G….
What is the basic purpose/significance of guessing high values of G..
Please confirm, whether guessed value of G is real or virtual…
Instead of considering many values of G, is there any possibility of choosing three different specific G values for weak, strong and electromagnetic

interactions.

Add a table or graph for various values of estimated G for the various masses of elementary particles.

ZEH cannot directly estimate the values of $\phi_{g(NEP)}$ for the massless photon (**ph**) $\phi_{g(ph)}$ and the gluon (**gl**) $\phi_{g(gl)}$ due to the division-by-zero error/paradox. However, ZEH additionally states that $\phi_{g(ph)}$ and $\phi_{g(gl)}$ may have very large values coinciding with $\phi_{g(en)}$, $\phi_{g(mn)}$ and $\phi_{g(tn)}$. More specifically, ZEH speculatively predicts that $\phi_{g(ph)} > \phi_{g(gl)}$ and that there also exists a massless graviton (**gr**) defined by $\phi_{g(gr)} > \phi_{g(ph)} \left(> \phi_{g(gl)}\right)$ so that: $\boxed{\phi_{g(gr)} = \phi_{g(en)}}$, $\boxed{\phi_{g(ph)} = \phi_{g(mn)}}$ and $\boxed{\phi_{g(gl)} = \phi_{g(tn)}}$. ZEH thus explains *the non-zero rest masses of 8 known or hypothetical NEPs (Zb, Hb, en, mn, tn, gl, ph and gr) plus their antiparticles by only five discrete ratios*: $\phi_{g(Zb)}$, $\phi_{g(Hb)}$, $\phi_{g(gr)}\left(=\phi_{g(en)}\right)$, $\phi_{g(ph)}\left(=\phi_{g(mn)}\right)$ and $\phi_{g(gl)}\left(=\phi_{g(tn)}\right)$.

The discrete values of ϕ_g for all the other (charged) EPs can also be easily determined by using the additional sub-hypothesis of ZEH $\left(\phi_g m_{EP}{}^2 \cong \phi_e q_{EP}{}^2\right)$ which simplifies the initial equation 6b and allows the estimation of ϕ_g as approximately $\phi_g \cong c^2 / m_{EP}$ for all known charged leptons, with slight variations in the case of quarks (depending on the exact fractional charge of those quarks): $\phi_g \cong 2c^2 / \left(\tfrac{13}{9} m_{EP}\right)$ (in the case of $\tfrac{2}{3}|e|$-quarks) and $\phi_g \cong c^2 / \left(\tfrac{5}{9} m_{EP}\right)$ in the case of $\tfrac{1}{3}|e|$-quarks).

Please explain the meaning and purpose of defining $\left(\phi_g m_{EP}{}^2 \cong \phi_e q_{EP}{}^2\right)$.

What are the estimated values of G for Graviton and Photon energy spectrums.

It is well established that, photon can be considered as a massive particle, $m \cong \dfrac{h}{c\lambda} \cong \dfrac{h\upsilon}{c^2}$. If so, for the entire family of photons, whether G value remains same or decreases with increasing mass of photon.

Very important question to be answered is, If Graviton is a particle associated with gravity, whether the magnitudes of G for Graviton and Newtonian Gravitational constants are same ? If not…Why? If yes..Why..?

5. Discussion

Add something for highlighting the merits of the paper with respect to current notion of unification of gravity and other forces. Discussion is the most important section in evaluating the credentials of any paper.

6. Conclusions

The energy/length scale-dependent *electro-gravitational resistivity of vacuum* $R(E)$ may determine both a variable $G_q(E)$ and $\alpha(E)$ bringing General relativity to quantum field theory more closer to one another: the same with the zero-energy hypothesis proposed in this paper which predicts a general formula for all the rest masses of all elementary particles from Standard model, indicating an unexpected profound bijective connection between the three types of neutrinos and the massless bosons (gluon, photon and the hypothetical graviton).

References