(toy-model) Sketching a new Quantum General Relativity (QGR) variant mainly based on the redefinition of leptons (as quantum micro black holes composed from highly compressed single triquarks under a very strong quantum gravitational field [QGF]), a dual electro-gravitational interpretation of the fine structure constant (FSC), Planck wormholes ("Planck tubes") and a reinterpretation of Planck units in the "spirit" of Einstein's GR

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Abstract (with abbreviations)

This paper sketches the toy-model of a new quantum General relativity (**QGR**) (aka "loop quantum gravity" [**LQG**]) variant mainly based on the redefinition of leptons (as quantum micro black holes [**mbhs**] composed from highly compressed single triquarks under a very strong quantum gravitational field [**QGF**]), a dual electro-gravitational interpretation of the (running) fine structure constant (**FSC**) and a reinterpretation of Planck units partially compatible with Einstein's GR (**EGR**) (or in the "spirit" of EGR!). QGR is born at the bridge between EGR, quantum field theory (**QFT**) and M-theory (**MT**): that is why QGR can be regarded as a "synapse" which interconnects these three apparently incompatible theories (EGR, QFT and MT). This QGR variant can be considered a specific MT subtype based on cylindrical 4D branes (called "vacuum tubes" in this paper) with 3D hyper-surfaces (3D branes): this MT subtype may act like a "patch"/"needle" "sticking"/"stitching" together both EGR and QFT.

This paper actually 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**]

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I. A quantum general relativity (QGR) variant – the main conjectures

(1) **(the main) Conjecture no.1 (Conj1) of this QGR redefining the leptons as quantum micro black holes (mbhs) containing extremely compressed single anti-hadrons**. Conj1 has two variants: one weaker version (**Conj1a**) and one stronger version (**Conj1b**). Conj1a states that the known matter of our universe (**OU**) is exactly counterbalanced by the antimatter of OU in EXACTLY equal number of particles (*a matter-antimatter symmetry principle of OU*) AND ALSO states that antimatter is actually "hidden right under our nose" and extremely compressed as known leptons, which leptons are defined by this QGR as quantum micro black holes (**mbh[s]**) containing extremely

compressed single (known) triquarks (baryons) (the main subtype of hadrons): stable leptons frequently found in OU are conjectured to be actually quasi-singularities composed from single (stable or unstable) anti-triquarks rarely found in OU (in exactly equal number to their corresponding triquarks, as those anti-triquarks would normally be too) AND (stable or unstable) leptons (rarely found in OU) are conjectured to be actually quasi-singularities composed from single stable (or unstable) triquarks frequently found in OU. More specifically, Conj1a states that:

a. **the electron (which is frequently found in OU) is actually a quantum quasi-singularity (mbh) composed from a single antiproton (which is rarely found in OU)** (conserving the negative elementary charge of that antiproton and its subcomponent two up-antiquarks and one down-antiquark): **the muon and tauon are considered two distinct excited states of the single-antiproton-mbh/electron** (as the antiproton also has analogous excited states); **the positron (which is rarely found in OU) is actually a quantum quasi-singularity (mbh) composed from a single proton (which is frequently found in OU)** (conserving the positive elementary charge of that proton and its subcomponent two up-quarks and one down-quark):

b. **the (zero-charge) electron-neutrino (which is frequently found in OU) is actually a quantum quasi-singularity (mbh) composed from a single (zero-charge) antineutron (which is rarely found in OU)** (conserving the subcomponent two down-antiquarks and one up-antiquark of that antineutron): **the muon-neutrino and tau-neutrino are considered two distinct excited states of the single-antineutron-mbh/electron-neutrino** (as the antineutron also has analogous excited states); **the (zero-charge) electron-antineutrino (which is relatively rarely found in OU) is actually a quantum quasi-singularity (mbh) composed from a single (zero-charge) neutron (which is frequently found in OU)** (conserving the subcomponent two down-quarks and one up-quark of that neutron): **the muon-antineutrino and tau-antineutrino are considered two distinct excited states of the single-neutron-mbh/electron-antineutrino** (as the neutron also has analogous excited states);

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c. **Conj1b (the stronger version of Conj1)** states that the known (plus unknown) matter of OU is exactly counterbalanced by the known (plus unknown) antimatter of OU in EXACTLY equal number of particles (*an extended matter-antimatter symmetry principle of OU*) AND ALSO states that NOT ONLY triquarks, BUT ALL hadrons and antihadrons from OU (baryons [made of an odd number of quarks: tri/penta-quarks] and mesons made of an even number of quarks [bi/tetra-quarks, usually one/two quark(s) plus one/two antiquarks of distinct type than the those quarks]) may have correspondent "leptonic" mbh-antihadrons ("exotic rare leptons"), from which some leptons (identified with the known or unknown **single-bi/tetra-quark-mbh** and with other known or unknown **single-triquark-mbhs**) are still unknown/undiscovered.

d. **Redefinitions (1)**. Conj1 (in both its Conj1a and Conj1b forms/variants) inversely redefine quarks as fragments of those single-triquark-mbhs (or fragments of single-hadron-mbhs in case of Conj1b) which CANNOT exist other than in bi/tri/tetra/penta-quark "unpacked"/"loose" combinations (as explained by color confinement at quantum chromodynamics [QCD] energy scale) or "packed"/mbh-compressed combinations (as explained by Conj1). Quarks packed in

single-triquark-mbhs may actually be considered preons: that is why this QGR has some similitude with preonic models (also related to preonic stars theory).

e. **Redefinitions (2a)**. Conj1 additionally redefines all electromagnetically (**EM**) charged +(2/3)q_e charm and top heavy quarks (with rest masses larger than the rest mass of the up-quark and the same electromagnetic charge [**EMC**] +(2/3)q_e as this up-quark) as being actually unstable excited states of the up-quark (with the argument that all these heavy quarks generally decay into an up-quark).

f. **Redefinitions (2b)**. Conj1 additionally redefines all electromagnetically (**EM**) charged (-1/3)q_e strange and bottom heavy quarks (with rest masses larger than the rest mass of the down-quark and the same electromagnetic charge [**EMC**] (-1/3)q_e as this down-quark) as being actually excited states of the up-quark (with the argument that all these heavy quarks generally decay into a down-quark).

g. **Redefinitions (3)**. Bosons with non-zero rest masses (like W bosons and Z boson, the quanta of the weak nuclear field [**WNF**] AND the Higgs boson, the quanta of the Higgs field [**HF**]) are ALSO stated by Conj1 to be actually N-quark-mbhs (with N being the number of quarks composing that boson).

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h. **Conjecture 1c (Conj1c) of QGR (which is a "patch" of Conj1, distinct from Conj1a and Conj1b) concerning the auto-repulsiveness of electromagnetic charge (EMC) and the impossibility to infinitely compress in a 3D volume two or more opposite-EMC quarks AND/OR any EP with non-zero EMC**. Conj1c states that a non-zero EMC (**nzEMC**) cannot be infinitely compressed in a 3D volume due to a conjectured inherent auto-repulsiveness of any nzEMC. Conj1c also states that OU doesn't allow two or more opposite nzEMC quarks AND/OR any EP with nzEMC to be infinitely compressed in a 3D volume: because all known (and unknown) leptons are conjectured by Conj1b to be hadron-mbhs, leptons (together with their subcomponent ultra-compressed quarks) and generally all EPs (quarks, leptons[=hadron-mbhs] and bosons) are thus conjectured to be compressible ONLY down to a non-zero finite and non-infinitesimal minimum length $l_{EP(\min)}$. Conj1c also conjectures that $l_{EP(\min)}$ is slightly smaller for EPs with zero-EMC (**zEMC**) than for EPs with nzEMC (because zEMC-EPs are conjectured to be slightly more compressible than nzEMC-EPs) so that:

$$\boxed{l_{nzEMC-EP(\min)} > l_{zEMC-EP(\min)} > 0m}.$$

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i. **Consequence/prediction no1. of Conj1**. Both Conj1a and Conj1b predict that OU (no matter if finite or infinite in size) has a zero global net electromagnetic charge (**EMC**). The equal number of electrons and positrons from our observable universe (**ObU**) may be also interpreted as an indirect proof for both Conj1a, Conj1b and the matter-antimatter symmetry principle of OU (which is a component of both Conj1a and Conj1b).

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j. **Consequence/prediction no.2 of Conj1**. Because Conj1a (and Conj1b) states that a neutrino is actually a highly compressed mbh-antineutron (composed from two down-antiquarks and one up-antiquark) which is DISTINCT from the antineutrino (which is also stated by the same Conj1a to be a highly compressed mbh-neutron composed from two down-quarks and one up-quark), Conj1a and Conj1b both thus predict that electron/muon/tauon-neutrinos and antineutrinos are actually Dirac fermions NOT Majorana fermions, so that the electron/muon/tauon-neutrino is predicted to NOT be its own antiparticle.

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k. **Consequence/prediction no.3a of Conj1**. Because any mbh has a finite and non-infinitesimal non-zero (positive) radius, all known (and unknown) leptons and generally all known (and unknown) elementary particles (**EPs**) (identified with hadron-mbh) are thus predicted to have finite and non-infinitesimal non-zero (positive) radii (which is in contrast with current quantum field theory [**QFT**] treating EPs as point-like entities, which isn't actually the case in this QGR variant): this solves the paradox of infinite self-energy of EPs (which implies paradoxal infinite massic/energetic density of EPs, equivalent to the paradox of singularity hypothetical existence).

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l. **Consequence/prediction no.3b of Conj1**. Furthermore and based on Conj1c, QGR also predicts that neutral (zero-EMC) (single-)triquark-mbhs (**tq-mbhs**) (identified with leptons) are more compressible than EM-charged tq-mbhs (but NOT infinitely compressible, as stated by Conj1c concerning auto-repulsiveness of any non-zero EMC): zero-EMC tq-mbhs are thus predicted to have smaller (positive finite and non-infinitesimal non-zero) radii than EM-charged tq-mbhs have.

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m. **As a checkpoint conclusion**, Conj1 (with its two variants Conj1a and Conj1b) may be an "exotic one-shot" (and quite… "tricky"!) solution for three major problems of the Standard model (**SM**) of particle physics, QFT and EGR: (**1**) the "missing" antimatter (which is conjectured to… NOT be missing at all, but to be actually "hidden" right …"under our nose"); (**2**) the debate on the neutrino being a Dirac or a Majorana particle (which is clearly "sliced" by Conj1 which predicts the neutrino (redefined as a single-neutron-mbh, which distinct from a single-antineutron-mbh) to be a Dirac fermion, like all the other known fermions of SM); (**3**) the paradox of infinite self-energy of the point-like EPs (as currently treated by QFT, which isn't actually the case in this QGR variant).

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2. **Conjecture no. 2 (Conj2) of QGR (which is very similar to Susskind-Maldacena ER=EPR strong conjecture launched in 2013) containing a redefinition of vacuum based on Conj1 (which redefines leptons as micro black holes [mbhs] composed from highly compressed single anti-triquarks)**. Conj2 states that the real (rest) mass of any (single-)hadron-mbh (**hdr-mbh**) (identified by Conj1b with any known/unknown lepton) is actually the mass of that hadron, NOT the mass of the equivalent lepton (**lep**) so that $\boxed{m_{hdr-mbh} \overset{def.}{=} m_{hdr}\left(>> m_{lep}\right)}$, which implies the same in the case of any (single-)triquark(**triq**)-mbh $\boxed{m_{triq-mbh} \overset{def.}{=} m_{triq}}$.

a. Conj2 "completes" Conj1 and pushes it "to extreme" by also stating that the (single-)triquark(**triq**)-lepton(**lep**) energy difference/"defect" of the (very high level of) compression in a leptonic (single-triquark-)mbh (**lmbh**)

$$\Delta E_{lmbh} \stackrel{def.}{=} \left(m_{triq} - m_{lep}\right)c^2 \stackrel{<}{\cong} 0.999 E_{triq}$$ (with

$$E_{triq} \stackrel{def.}{=} m_{triq}c^2$$ and because $m_{lep} \stackrel{<}{\cong} 10^{-3} m_{triq}$ for

stable light leptons) IS ACTUALLY produced by and extreme quantum gravity (**EQG**) (assigned a <u>strong quantum gravitational constant</u> [**SGC**] $G_q \gg G$) "pushing" the

majority of gluons (with their kinetic energy normally accounting for ~99% of a triquark rest mass) and at least 90% of the rest masses of those subcomponent quarks/antiquarks (of that triquark-mbh) out of our 3D space (**3DS**) in a 4th (spatial) dimension (**4thD**): gluons are stated to literally "punch out" our 3DS and "evade" in a 4thD creating a huge number of Planck wormholes (**PWHs**) (as also proposed by Susskind and Maldacena, as explained next) which interconnect that lmbh with all the other elementary particles (**EPs**) of OU: <u>these PWHs are ALSO defined by Conj2 as still being a part (a "hidden" one in the 4thD) of that leptonic triq-mbh, with those PWHs accounting for ~99.9% of the real mass of that leptonic triq-mbh (which real mass is identified with the rest mass of that triquark)</u>. **Co-statement**. <u>The 4DPTs formed by each PT-"creator" EP in part (which interconnect that EP with many other EPs from our 3D space [**3DS**]) are conjectured to be (relatively) uniformly spread in the surrounding 3DS of that PT-"creator" EP</u>: additionally, all EPs are stated to be actually PT-"creators"/generators.

b. **Additional statement of Conj2**. Conj2 additionally states that a finite ΔE_{lmbh} can only generate a finite number of (**nof**) such PWHs so that any EP can only be *simultaneously* interconnected with a finite nof other distinct EPs from OU at any specific instance of measurement/observation. Conj2 redefines the spacetime (**ST**) vacuum (**vac**) of OU as a conglomerate of <u>interwoven (hyper-) cylindrical 4D PWHs/"Planck tubes"</u> (**PTs/4DPTs**: called "Planck tubes" for acronymic simplicity) which connect each real and virtual EP (defined as mbh) from OU with other EPs from OU: each 4DPT is stated to be 4D cylinder with possibly infinite length composed from a 3D hyper-surface (**3DHS**) (which is identified with our observable 3D space [**3DS**]) curved and closed around a "temporal" 4thD with <u>compact topology</u>; each PT is actually defined as a 3D brane (**3Db**) circularly closed around a 4thD with infinite-length cylindrical-shape; the 4DPT is thus defined as a wormhole subtype and considered by this QGR to be the "morpho-functional" basis of our 4D spacetime (**4DST**).

c. **Important co-statement (0)**. Conj2 additionally states that gluons travel through those PTs ("digged" in the 4thD) with finite speeds (but which may appear infinite speeds when measured from our 3DS) and <u>may mediate quantum entanglement</u> (**QE**). Conj2 ambitiously co-states that those entanglement-mediating gluons (that escape to the 4thD through these 4DPTs) may actually gain an additional degree of spin-freedom, becoming 2-spin bosons identifiable with the hypothetical gravitons, so that the gravitons are conjectured to exist and to be actually 2-spin gluons traveling through 4thD and mediating QE. **Important explanation**. <u>The uniform spread of 4DPTs</u> (generated by each EP in part) AND <u>the gluon-graviton identity/equivalence in the 4thD</u> may explain the <u>inverse-square law</u> (**ISL**) of gravity by the dissipation of gravitons (traveling through these generated 4DPTs) on a spherical surface/area of emission with progressively larger area (depending on the squared radius of that spherically-radial dissipation of gravitons mediating gravity).

d. **Important co-statement (1)**. Conj2 additionally states that 3DHSs are <u>positive energy (**pe**) 3D branes (pe3-branes identified with the scalar Higgs field (**HF**) quantized by the Higgs boson)</u> AND that <u>4thD has a "suctional" (suction-like) effect</u> on those (closed) cylindrical pe3-branes (identified with our 3DST) so that <u>4thD is actually stated to have negative energy</u> (similarly to the attractive-only gravitational field [**GF**] which is standardly modeled as a <u>negative energy field</u> too). However, the 4[th]D is stated to have at least two main compartments: (**1**) the inner 4thD hypervolume (**in4thDHV**) "trapped" inside any 4DPT (which suctions and stabilizes the cylindrical 3DHS "walls") AND (**2**) the outer 4thD hypervolume (**out4thDHV**) from outside any 4DPT (which is stated to suction all 4DPTs from outside keeping them in a relative compact macro-configuration).

e. **Important co-statement (2)**. Furthermore (and even more ambitiously!), Conj2 states that <u>the total positive energy of all pe-3-branes of OU exactly cancels out the total negative energy of the suctional 4thD (in4thDHV plus out4thDHV) so that the total energy of our universe is zero</u> no matter if infinite in size or not (see the zero-energy universe hypothesis [**ZEUH**] in the literature). **Speculation on life forms and psi phenomena**. Both these in4thDHV and out4thDHV may be "populated" by a plethora of types of unknown EPs that may be organized even more complexly than those from our 3DS (including known life forms [**LFs**]) and these unknown EPs may explain <u>psi phenomena</u> [**23**] and the myths about the existence of immortal spirits (which may actually be true); the bodies of known LFs may actually be in subtle connections with other unknown LFs from in4thDHV and out4thHV (the whole evolution of LFs from our 3DS can actually be conducted from those 4thDHVs).

f. **Important co-statement (3)**. Various unknown EPs (probably bosonic EPs!) are stated to travel inside or outside 4DPTs (through the in4thDHV or out4thDHV) at finite or infinite speeds and so to mediate <u>quantum entanglement (which is thus conjectured to be mediated via the 4thD and to be in fact an indirect subtle proof for the existence of this 4thD!)</u>. Additionally, the finite-speed vibrations of 3DHSs/pe3-branes (of 4DPTs) are co-stated to actually "mediate all types of known (or still unknown!) fundamental physical forces (**FPFs**): <u>gluons</u> (the quanta of the <u>strong nuclear field</u> [**SNF**]), <u>photons</u> (the quanta of the <u>electromagnetic field</u> [**EMF**]) and <u>gravitational waves</u> (**GWs**) (the "quasi-quanta" of GF, no matter if composed from <u>hypothetical gravitons</u> or not) are all stated to be actually distinct types of finite-speed waves traveling along these 3DHSs/pe3-branes (of 4DPTs) between various types of EPs which couple with SNF, EMF and/or GF; the W/Z bosons (the quanta of the weak nuclear field [**WNF**]) is also stated to gain its mass from the Higgs field (**HF**) (identified with pe3-branes/3DHS of any 4DPT) so that to be also a quantized wave traveling along the 3DHSs/pe3-branes (of 4DPTs). **Important note**. This QGR redefinition is actually the strong form of <u>"ER=EPR" conjecture</u> (proposed by Leonard Susskind and Juan Maldacena in 2013) which states "<u>any entangled pair of particles (EPs or non-EPs)—even particles not ordinarily considered to be black holes, and pairs of particles with different masses or spin, or with charges which aren't opposite—are connected by Planck scale wormholes (**PWHs**), so that the geometry of space, time and gravity is essentially determined by entanglement</u>".

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3. **<u>Conjecture no. 3 of QGR (Conj3) estimating the maximum magnitude of the strong gravitational constant (SGC) as based on both Conj1 (including Conj1c) and Conj2</u>**. Let us consider a hypothetical quantum mbh with rest mass m_{mbh} and its definitory condition of existence: that its Schwarzschild radius $\boxed{r_{S(mbh)} = 2m_{mbh}G/c^2}$ to be equal to its Compton wavelength $\boxed{\lambda_{C(mbh)} = h/(m_{mbh}c)}$, from which the minimum mass allowed for any mbh is thus deduced to be $\boxed{m_{mbh} = \sqrt{\pi\hbar c/G}}$ with a radius $\boxed{r_{mbh}\left(= \lambda_{C(mbh)} = r_{S(mbh)}\right) = \sqrt{4\pi\hbar G/c^3}}$. At least in principle, <u>Planck mass</u> $m_{Pl}\left(=\sqrt{\hbar c/G}\right) = m_{mbh}/\sqrt{\pi}$ is considered a plausible candidate for the lower mass bound for any black hole (including mbh), with the reserve of the possible existence of additional large extra dimensions (**LEDs**) and/or compact-topology EDs (**CEDs**) predicted by supersymmetric string theories (**SSTs**) and M-Theory (**MT**) (including this QGR variant which also considers a 4thD, like EGR does too), which may also imply the existence of a set of quantum big G values $G_q > G$ (<u>strong gravitational constants</u> [**SGCs**]) and implicitly $\boxed{m_{mbh}\left(=\sqrt{\pi\hbar c/G_q}\right) < m_{Pl}}$ at sufficiently small length scales at which the majority of the (hypothetical) gravitons emitted by any body are predicted to won't have yet "escaped" our 3D space in those hypothetical LEDs/CEDs: a minimum m_{mbh} is thus related to a maximum G_q such as $\boxed{m_{mbh(\min)} = \sqrt{\pi\hbar c/G_{q(\max)}}}$ and a minimum G_q defined as $\boxed{G_{q(\min)} \overset{def.}{=} G\left(\cong 6.674\times10^{-11} m^3 kg^{-1} s^{-2}\right)}$.

a. **Conj3 chooses the <u>electron neutrino</u> (<u>en</u>) (which is the lightest known EP, also a zero-EMC EP predicted by Conj1c to be the most spatially compressed single-triquark-mbh, with <u>apparent rest mass</u> presently estimated as $\boxed{m_{en} \cong 1eV/c^2\left(<< m_{Pl}\right)}$) AND ambitiously states that the <u>real (r) rest mass of en</u> (which is conjectured by Conj1a to be actually equal to the rest mass of a single neutron $\boxed{m_{en(r)} = m_n\left(\cong 0.94GeV\right)\left(>> m_{en}\right)}$, because en is defined as a single-neutron-mbh by the same Conj1a) IS ACTUALLY the lightest and smallest conceivable single-triquark-mbh allowed in OU, so that**:

$$\boxed{m_{mbh(\min)}\left(=\sqrt{\pi\hbar c/G_{q(\max)}}\right) = m_{en(r)} = m_n\left(\cong 0.94GeV\right)} \quad \textbf{(1a)}$$

$$\boxed{r_{en(\max)} = r_{mbh(\max)} = \sqrt{4\pi\hbar G_{q(\max)}/c^3}} \quad \textbf{(1b)}$$

$$\boxed{r_{en(\min)} = r_{mbh(\min)} = \sqrt{4\pi\hbar G_{q(\min)}/c^3} = \sqrt{4\pi\hbar G/c^3} = \sqrt{4\pi}\,l_{Pl}} \quad \textbf{(1c)}$$

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b. From equation 1a, $G_{q(\max)}$ can be reversely deducted as:

$$\boxed{G_{q(\max)} \overset{estim.}{=} \pi\hbar c/m_n^2 \cong 5.3\times10^{38}G} \quad \textbf{(1d)}$$

c. From equation 1d, $r_{en(\max)}$ can be then deducted as

$$\boxed{r_{en(\max)} = \sqrt{4\pi\hbar G_{q(\max)}/c^3} = h/(m_n c) = \lambda_{C(n)} \cong 1.51 r_p}$$

which $r_{en(\max)}\left(= \lambda_{C(n)} \cong 1.51 r_p\right)$ is very close to the radius of a single neutron (which is approximately equal to the radius of the proton $r_p \cong 0.84\,fm$)

d. Conj3 thus defines a variable quantum big G varying inverse-proportionally with the length scale (thus direct-proportionally with the energy scale) between $\boxed{G_{q(\min)} \overset{def.}{=} G\left(\cong 6.674\times10^{-11} m^3 kg^{-1} s^{-2}\right)}$ and $\boxed{G_{q(\max)} \overset{estim.}{=} \pi\hbar c/m_n^2 \cong 5.3\times10^{38}G}$, with $\boxed{G_{q(\max)}/G_{q(\min)} \overset{estim.}{=} \pi\left(m_{Pl}/m_n\right)^2\left(\cong 5.3\times10^{38}\right)}$. $G_{q(\max)}$ corresponds to a maximum quantum <u>gravitational coupling constant</u> (**GCC**) $\boxed{\alpha_{q(\max)} \overset{estim.}{=} G_{q(\max)}m_e^2/(\hbar c) \cong 10^{-6}}$ which is very close to the strength of the weak nuclear field (**WNF**) at the nuclear length scale (measured by $r_p \cong 0.84\,fm$, more precisely $\boxed{\alpha_{WNF}\left(\hbar c/(r_p/5)\right) \cong \alpha_{q(\max)} \cong 10^{-6}}$, with $$\boxed{\alpha_{WNF}(E) = \frac{E_W G_F/(\hbar c)^3}{e^{E_W/E}}}$$ being the running coupling constant of WNF as a function of a variable energy scale E, $E_W = m_W c^2 \cong 80.4GeV$ being the rest energy of the W boson [which is the propagator quanta of WNF], $G_F/(\hbar c)^3 \overset{exp.}{\cong} 1.2\times10^{-5}GeV^{-2}$ being the experimentally determined Fermi coupling constant, with $G_F \overset{exp.}{\cong} 1.44\times10^{-62}Jm^3$), a fact which indicates that GF and WNF are potentially unifiable in a future <u>theory of everything</u> (**TOE**).

e. The $x_{en} = r_{en(\max)}/r_{en(\min)}\left(= \sqrt{G_{q(\max)}/G} \cong 2.3\times10^{19}\right)$ ratio is conjectured (by the same Conj3) to generally measure the maximum rate of compression of any triquark into a lepton (defined as a single-triquark-mbh).

f. **<u>Important co-statement (1) of Conj3</u>**. Conj3 "pushes" itself to "extremes" by also stating that the mass defect of a lepton (defined as a single-triquark-mbh) may be actually

much larger than previously estimated

$$\Delta E_{lmbh} \overset{def.}{=} \left(m_{triq} - m_{lep} \right) c^2 \overset{<}{\cong} 0.999 E_{triq}$$, more

specifically proposing a (corrected) extreme <u>leptonic mass defect</u> (**lmd**) as a function of $m_{mbh} = m_{Pl}\sqrt{\pi}$ such as

$$\Delta E_{lmd} \overset{def.}{=} \left(m_{mbh} - m_{lep} \right) c^2 >> \Delta E_{lmbh}$$ which may

be actually converted to a much larger number of Planck wormholes (**PWHs**) possibly interconnecting each lepton with all the other elementary particles (**EPs**) of OU (which EPs may actually be finite in their total number, because ΔE_{lmd} is also finite).

g. **Important co-statement (2) of Conj3**. Conj3 ALSO states that, when compressing a triquark(**triq**)(-baryon), the kinetic energy of the gluons contained in that triq grows exponentially leading to an exponential increase of the rest mass of that triq up to m_{mbh}, with the important remark that those "hyperkinetic" gluons actually punch out from our 3DS progressively and create a large number of PWHs (and that is why the huge mass excess generated by compression won't be measured as m_{mbh} and NOT EVEN as m_{triq}, but ONLY as m_{lep}).

h. **Important observation**. The <u>electron</u> (**e**) and its antiparticle (the <u>positron</u>) are the EPs with the largest known redefined dimensional ratio

$$\left| q_e \right| / m_e \cong 1.76 \times 10^{11} C/kg$$ (defining the maximum

rate of compression [as known in OU] of the elementary charge q_e per unit of rest mass of an EP) and a correspondent dimensionless ratio

$$x_e = \left| q_e \right| \sqrt{k_e} / \left(m_e \sqrt{G} \right) \cong 2.04 \times 10^{21}$$ (with

$k_e \cong 8.99 \times 10^9 Nm^2/C^2$ being the <u>Coulomb constant</u> in vacuum AND $\left| q_e \right| \cong 1.6 \times 10^{-19} C$ being the <u>absolute value</u> of the <u>elementary EMC</u> assigned to both the electron and the positron): $x_e \left(\cong 2.04 \times 10^{21} \right)$ has a value relatively close to $x_{en} \left(\cong 2.3 \times 10^{19} \right)$ which indicates/suggests that a quantum strong gravitational field (**QSGF**) (measured by $G_{q(max)}$ at the finite non-zero size scale of the electron and any EP in general) may be directly involved in charge spatial/volumic compression in any EP with nzEMC (including the electron).

i. **Important co-statement (3) of Conj3**. Conj3 ALSO states that the attractive QSGF counteracts SNF (which SNF becomes very repulsive at those very small length scales) so that the attractive QSGF and the repulsive SNF may reach equilibrium at length scales $r_{mbh(min)}$ (comparable to the Planck scale l_{Pl}).

j.

k. **Important co-statement (4) of Conj3**. Conj3 also states that all hadrons may actually oscillate between these two extreme forms (quantum gravitational states): (**1**) their unpacked form (usual hadrons) AND (**2**) their "allotropic" ultra-compact single-antihadron-mbh form (identified with known and unknown leptons) defined by the compression ratio x_{en}. Hadrons and antihadron-mbhs (identified with leptons) (two extreme quantum gravitational states of hadrons and leptonic single-antihadron-mbhs governed by QSGF) can thus <u>coexist WITHOUT reciprocal annihilation in the same universe</u>, given the minimal surface/horizon area of hadron/antihadron-mbh which indicates a zero probability of reciprocal annihilation.

l. **Important interpretation**. The weak macroscopic gravitational field (**mGF**) (with strength measured by

$$G_{q(min)} \left(\overset{def.}{=} G \right)$$) is interpreted by Conj3 as being a

residual form of the quantum strong gravitational field (**QSGF**) acting at Planck scales and inside single-hadron-mbhs (identified with leptons by Conj1): Conj3 explains the very large strength ratio between QSGF and mGF (measured by the ratio

$$G_{q(max)} / G_{q(min)} = G_{q(max)} / G \cong 5.3 \times 10^{38}$$) by the

fact that a very small fraction of hypothetical gravitons manage to escape these "leptonic" single-antihadron-mbhs into their surrounding 3D space (**3DS**).

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4. **Conjecture no. 4 of QGR (Conj4) regarding a dual electro-gravitational interpretation of the fine structure constant (FSC)**. Conj4 starts from the interesting observation that

$$\alpha_S / \alpha \cong \log_2 \left(\alpha / \alpha_G \right) \cong 1/140 \cong \alpha$$ (**equation 2a**) , which is

equivalent to $\alpha / \alpha_G \cong 2^{\alpha_S/\alpha}$ (**equation 2b**) and

$$\alpha_G \cong \alpha / 2^{\alpha_S/\alpha}$$ (**equation 2c**), with the following notations:

$\alpha_S \cong 1$ [URL] being the <u>running coupling constant</u> of the strong nuclear field (**SNF**)

$$\alpha_{SNF}(E) = \frac{12\pi}{\left(22 - 2n_f \right) \ln \left(E / E_{QCD} \right)} = \frac{6\pi}{5 \ln \left(E / E_{QCD} \right)}$$ (a

formula only valid for $E >> E_{QCD}$) at the energy scale of a proton at rest $E = E_p = m_p c^2 \cong 0.94 GeV$, more precisely $\alpha_{SNF} \left(1.5 E_p \right) \cong 1.01$ (which is a function of the number of quark flavors $n_f = 6$ and the energy scale quantum chromodynamics [**QCD**] $E_{QCD} \cong 0.22 GeV$);

$\alpha = k_e q_e^2 / \left(\hbar c \right) \cong 1/137$ being the <u>running coupling constant</u> of the electromagnetic field [**EMF**]

$$\alpha_{EMF}(E) = \frac{\alpha}{1 - (\alpha/3\pi) \ln \left(E^2 / E_e^2 \right)}$$ at the energy scale of an

electron at rest $E = E_e = m_e c^2 \cong 0.51 MeV$ (also known as FSC at rest, valid for scales larger than electron's Compton wavelength $E = \lambda_{C(e)} = hc / E_e \cong 2.4 \times 10^{-12} m$) [24];

$$\boxed{\alpha_G = G m_e^2 / (\hbar c) \cong 1.75 \times 10^{-45}}$$ being the gravitational coupling constant (GCC) (standardly defined as a function of the electron rest mass $m_e \cong 0.51 MeV / c^2$ and measuring the strength of the gravitational field [GF]). Conj4 considers the three (reciprocally equivalent) previous equations (2a, 2b and 2c) to NOT be just a simple coincidences and conjectures a generalized equation defining a generalized quantum big G $G_q(E)$ (varying with the energy scale) and a variable quantum GCC (assigned to a quantum gravitational field [QGF] with variable strength) $\alpha_{QGF}(E)$ being a function of this $G_q(E)$, such as:

$$\boxed{G_q(E) = (\hbar c / m_e^2) \alpha_{EMF}(E) / 2^{\alpha_{SNF}(E)/\alpha_{EMF}(E)}} \quad (3a)$$

$$\boxed{\alpha_{QGF}(E) = G_q(E) m_e^2 / (\hbar c) = \alpha_{EMF}(E) / 2^{\alpha_{SNF}(E)/\alpha_{EMF}(E)}} \quad (3b)$$

a. Conj4 actually proposes a smooth transition from $G_{q(min)} \left(\overset{def.}{=} G \right)$ to $\boxed{G_{q(max)} \left(\overset{estim.}{\underset{Conj3}{=}} \pi \hbar c / m_n^2 \cong 5.3 \times 10^{38} G \right)}$ (previously estimated by the Conj3) by using this E-depending variable $G_q(E)$, with $\boxed{G_{q(max)} \cong G_q(10^{-11.5} E_{Pl})}$. The logarithmized graph of $G_q(E)$ is presented **next**:
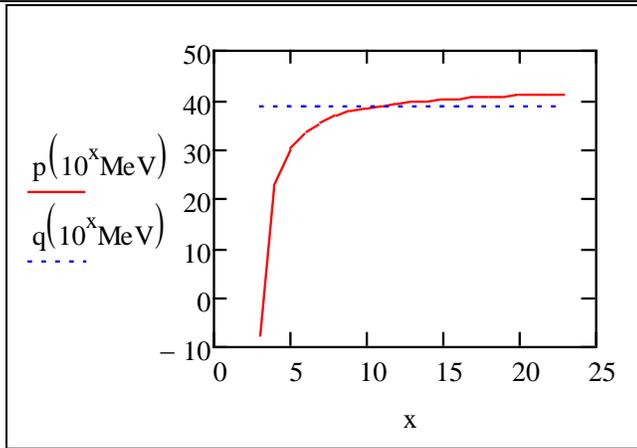
Image 1. The comparative graph of both
$p(E) = \log_{10}\left[G_q(E) / G \right]$ and $q(E) = \log_{10}\left[G_{q(max)} / G \right]$
for $E = 10^x MeV$ and
$x \in \left[\log_{10}(E_{QCD} / 1MeV) + 1 (\cong 3), \log_{10}(E_{Pl} / 1MeV) + 1 (\cong 23) \right]$

b. Very interestingly, the graph of $\alpha_{GF}(E)$ (the predicted running coupling constant of the quantum gravitational field [QGF]) has a growth pattern similar to the graph of the (previously explained) running coupling constant of WNF

$$\boxed{\alpha_{WNF}(E) = \frac{E_W G_F / (\hbar c)^3}{e^{E_W / E}}}$$ (with a pattern of unification between QGF and WNF around Planck energy scale, which is another argument for QGF and WNF being unifiable at those sufficiently large energy scales): **see the next image**.
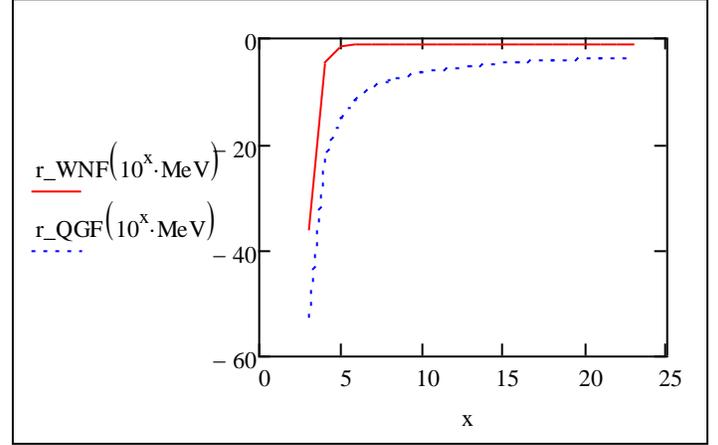
Image 2. The comparative graph of both
$r_{WNF}(E) = \log_{10}\left[\alpha_{WNF}(E) \right]$ and
$r_{QGF}(E) = \log_{10}\left[\alpha_{QGF}(E) \right]$ for $E = 10^x MeV$ and
$x \in \left[\log_{10}(E_{QCD} / 1MeV) + 1 (\cong 3), \log_{10}(E_{Pl} / 1MeV) + 1 (\cong 23) \right]$

c. **Important note (1)**. From the previous image, one may easily notice that $\alpha_{QGF}(E)$ grows rapidly with the energy scale (being however negligible at atomic size scale $l_a \cong 10^{-10} m$ corresponding to an energy scale $E_a = hc / l_a \cong 10^{-2} MeV$) up to an inflexion (**i.**) point (**ip**) (from which it grows much slower with the increasing energy scale), which ip corresponds to an energy scale $\boxed{E_{QGF(i)} \cong 10^6 MeV}$ and to a subnuclear (Compton) length scale $\boxed{l_{QGF(i)} = hc / E_{QGF(i)} \cong 10^{-18} m}$ $\left(\cong r_p / 10^3 \right)$ (with $r_p \cong 0.87 \times 10^{-15} m$ being the proton radius): even more interestingly, $E_{QGF(i)} \left(\cong 10^6 MeV \right)$ is approximately one order of magnitude larger than the rest energies (**E**) of the Higgs boson (**Hb**) $\left(E_{Hb} \right)$ and top quark (**tq**) $\left(E_{tq} \right)$ (which are the heaviest known elementary particles) so that $\boxed{E_{QGF(i)} / E_{Hb} \cong 8}$ and $\boxed{E_{QGF(i)} / E_{tq} \cong 5.7}$; it is also interesting that the length-ratio $\boxed{d_p / l_{QGF(i)} (\cong 1403)}$ is relatively close to the mass-ratio $\boxed{m_p / m_e (\cong 1836)}$.

d. **Important note (2).** This newly proposed

$$G_q(E) = \left(\hbar c / m_e^2\right) \alpha_{EMF}(E) / 2^{\alpha_{SNF}(E)/\alpha_{EMF}(E)}$$

(**equation 3a**) also better estimates the maximum value of G_q as a corrected

$$G_{q(max)(c)} \overset{estim.}{=} G_q(E_{Pl}) \cong 10^{41} G \cong 228 \cdot G_{q(max)}$$

(which is relatively close, with just two orders of magnitude larger than the previously estimated (by Conj3)

$$G_{q(max)}\left(\overset{estim.}{=} \pi\hbar c / m_n^2 \cong 5.3 \times 10^{38} G\right):$$ this shows a

relative coherence and convergence between Conj3 and Conj4. **Additional note.** Interestingly enough, the ratio

$$G_{q(max)(c)} / G_{q(min)}\left(\cong 1.2 \times 10^{41}\right)$$ has the same order

of magnitude as the ratios (implying proton and neutron rest

masses) $\boxed{m_{Pl}^2 / \left(m_p m_e\right)\left[\cong m_{Pl}^2 / \left(m_n m_e\right) \cong 3.1 \times 10^{41}\right]}$.

e. **Subconjecture of Conj4 (on the dual electro-gravitational significance of the running FSC).** One may notice that α and α_{EMF} are "junction"-terms in the equations

$$\alpha_S / \alpha \cong \log_2\left(\alpha / \alpha_G\right)$$ (**equation 2a**) and

$$\alpha_{SNF} / \alpha_{EMF} \cong \log_2\left(\alpha_{EMF} / \alpha_{QGF}\right)$$ (**which is the logarithmic equivalent of equation 3b**) respectively (with α and α_{EMF} being present in both left and right parts of these equations): based on this fact, Conj4 also states that α_{EMF} has actually a "hybrid"/dual electromagnetic and gravitational significance, acting like a binary logarithmic strength "tuner" between SNF and QGF (through EMF).

f. **Important prediction of Conj4.** Conj4 also states that the similitude between $\alpha_{WNF}(E)$ and $\alpha_{QGF}(E)$ graphs (with $\alpha_{WNF}(E)$ variation graph also having an inflexion point corresponding to the rest energy of the W boson $E_W \cong 80 GeV$ and to $x = \log_{10}\left(E_W / 1MeV\right) \cong 4.9$, as also visible in the previous graph) actually suggests that the hypothetical graviton (**gr**) could be actually a **heavy spin-2 boson** with non-zero rest energy E_{gr} close to

$$E_{QGF(i)}\left(\cong 8E_{Hb} \cong 1TeV\right):$$ **the highly-compressed "preonic" quarks from inside a triquark-mbh are thus stated to interchange the kind of virtual ultra-heavy/massive hypothetical/conjectured gravitons (the identified with the quant of QGF).** Conj4 also considers these two possibilities: (**1**) EITHER what we measure as macroscopic/macrocosmic gravity is only a "residual" force/field (residual QGF) generated by exchange of heavy gravitons at subnuclear scales; (**2**) OR there are actually two types of spin-2 gravitons (a heavy one mediating gravity at subnuclear scales [QGF] AND a massless one mediating QGF at supra-nuclear atomic, microscopic and macroscopic/macrocosmic scales). **Note.** The predicted rest energy of this heavy spin-2 graviton (mediating QGR at subnuclear scales up to Planck scales)

$$E_{gr}\left(\cong E_{QGF(i)} \cong 1TeV\right)$$ is almost one order of

magnitude larger than the lower bound (**lb**) energy $E_{lb} \cong 170 GeV$ established by quantum electrodynamics (**QED**) to be assignable to any possible (super-heavy) subcomponent of the electron (that may exist and act inside a hypothetically composite electron), with $E_{lb}\left(\cong 170 GeV\right)$ being actually deducted from very small difference $\left|\delta a\right|\left(< 8.3 \times 10^{-12}\right)$ between the value of the electron magnetic moment that we measure in Bohr magnetons (called g/2) and the value of g/2 as predicted by QED as a function of FSC (α) at rest (called g/2(α)) [URL].

g. **Checkpoint conclusion (with additional graph).** All known fundamental forces/fields can be comparatively represented on the same graph, showing a unifying pattern close to Planck energy scale: **see the next image** (containing a graph which clearly shows that the strength of QGF approaches very closely the strength magnitudes of the other three fundamental physical fields [**FPFs**] at energy scales $E \in \left[10^{14}, 10^{15} MeV\right]\left(<< E_{Pl}\right)$ (corresponding to a length scale interval $l \in \left[10^8 l_{Pl}, 10^9 l_{Pl}\right]\left(>> l_{Pl}\right)$ which is approximately 4 orders of magnitude lower than the upper limit [**ul**] of the electron diameter $d_{e(ul)} = 10^{-22} m\left(>> l_{Pl}\right)$, as estimated by using electrons trapped in Penning traps [URL]), a fact that raises a great hope for all 4 known FPFs to be actually unifiable at energy scales much lower than E_{Pl} which are hypothetically achievable in other large hadron colliders (**LHCs**) potentially constructible in the distant future.
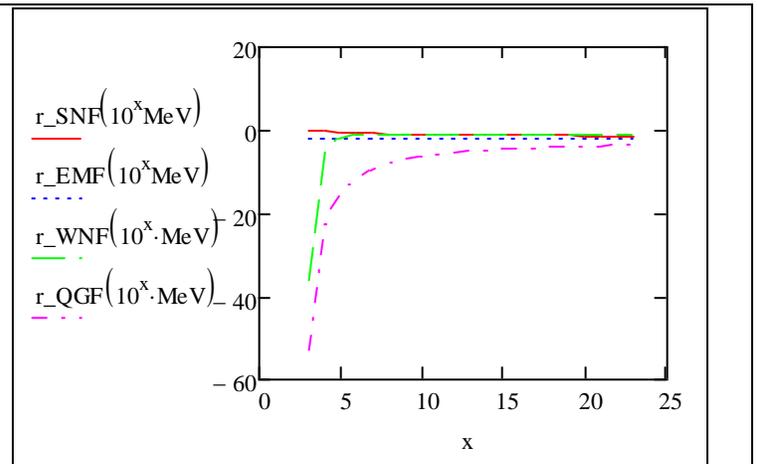

Image 3. The comparative graph (with a pattern of unification around Planck energy scale) of $r_{SNF}(E) = \log_{10}\left[\alpha_{SNF}(E)\right]$, $r_{EMF}(E) = \log_{10}\left[\alpha_{EMF}(E)\right]$, $r_{WNF}(E) = \log_{10}\left[\alpha_{WNF}(E)\right]$ and $r_{QGF}(E) = \log_{10}\left[\alpha_{QGF}(E)\right]$ for $E = 10^x MeV$ and $x \in \left[\log_{10}(E_{QCD} / 1MeV) + 1\left(\cong 3\right), \log_{10}(E_{Pl} / 1MeV) + 1\left(\cong 23\right)\right]$

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5. **Conjecture no.5 of QGR (Conj5) (as based on all previous conjectures Conj1&2&3&4).** Based on Conj1&2, Conj5 actually pushes to extremes Conj3&4. Conj5 actually has two variants: one "weaker" Conj5a version and one "stronger" version Conj5b ("stronger" when compared to Conj5a which is its "weaker" variant). **Conj5a.** Conj5a states **that all known baryons have actually four extreme states of compression (expressed here as linear densities)**: (**1**) the "loosest"/"rarefied" state (of all four), which corresponds to the measured (rest) mass of a known baryon $\left(m_{bar}\right)$ AND its measured diameter $\left(d_{bar}\right)$

$$\boxed{\rho_{EP(\min)} = \rho_{EP(1)} = m_{bar} / d_{bar}}$$ (for example

$m_p / d_p \cong 10^{-12} kg/m$); (**2**) a compacter state, which corresponds to the measured (rest) mass of its corresponding lepton (**lep**) $\left(m_{lep}\right)$ (identified with that highly-compressed single-baryon-mbh, as defined by Conj1) AND its mbh-diameter $\left(d_{mbh} = 2l_{Pl}\sqrt{4\pi}\right)$ $\boxed{\rho_{EP(2)} = m_{lep} / d_{mbh}}$ (for example $m_{e+} / d_{mbh} \cong 10^4 kg/m$ in the case of the positron $\left[e^+\right]$, which is defined as a single-proton-mbh, with mass $m_{e+} = m_e$ [equal to that of the electron]); (**3**) and even compacter state, which corresponds to the measured (rest) mass of a known baryon $\left(m_{bar}\right)$ AND its mbh-diameter $\left(d_{mbh}\right)$ $\boxed{\rho_{EP(3)} = m_{bar} / d_{mbh}}$ (for example $m_p / d_p \cong 10^7 kg/m$); (**4**) the densest/ compactest state (of all four) which corresponds to the measured (rest) mass of a micro black hole (**mbh**) $\left(m_{mbh} = m_{Pl}\sqrt{\pi}\right)$ (which mbh may compress a large number of baryons, quarks and leptons to their maximum limit of massic compression) AND its d_{mbh} $\boxed{\rho_{EP(\max)} = \rho_{EP(4)} = m_{mbh} / d_{mbh} \cong 10^{26} kg/m}$;

$\rho_{EP(\max)}$ is actually very close to the Planck linear density

$$\boxed{\rho_{Pl(lin)} = m_{Pl} / l_{Pl} \left(= c^2 / G \cong 10^{27} kg/m\right)}, \quad \text{so that}$$

$\rho_{Pl(lin)} = 4\rho_{EP(\max)}$. **Conj5b.** Conj5b states that **NOT ONLY all known baryons, BUT possibly all conceivable (known/unknown) hadrons have actually those four extreme states of compression (expressed as linear densities by Conj5a).**

a. **Important co-statement (1) of Conj5.** Conj5 ALSO states that all known EPs of OU have the same diameter $\boxed{d_{EP(const)} = d_{mbh}}$ and various densities (at rest) depending on the rest masses of their corresponding baryons (as conjectured by Conj1), such as $\boxed{\rho_{EP(var)} = m_{bar} / d_{mbh}}$.

b. **Important co-statement (2) of Conj5.** Conj5 ALSO states that $\rho_{EP(\max)}\left(\cong 10^{26} kg/m\right)$ is NOT ONLY the maximum density to which any EP can be compressed, BUT also (deductively) the maximum density allowed in OU above which QGF becomes repulsive and drastically opposes to any further volumic/spatial compression: Conj5 also (inductively)

states that $\rho_{EP(\max)}\left(\cong 10^{26} kg/m\right)$ was probably the density of the pre-Big Bang (quasi-)Singularity (**pBBS**) which is redefined by Conj5 as **a gravitational quasi-singularity with huge but finite (non-infinite) density** (unlike paradoxical true singularities predicted by EGR). pBBS is thus defined as the sum of all mbhs, with each mbh being obtained from "fusing" in "chunks" all the single-hadron-mbhs (identified with quarks and leptons). $\rho_{EP(\max)}\left(\cong 10^{26} kg/m\right)$ corresponds to a 3D volumic density

$$m_{mbh} / \left[\left(4\pi/3\right)\left(d_{mbh}/2\right)^3\right] \cong 5\times10^{94} kg/m^3 \quad \text{which has}$$

an intermediary value between the predicted density of a hypothetical preon star (**ps**) $\left(\rho_{ps} \cong 10^{26} kg/m^3\right)$ and Planck density $\rho_{Pl}\left(= m_{Pl} / l_{Pl}{}^3 \cong 5\times10^{96} kg/m^3\right)$ (obviously much larger than ρ_{ps} and very close to ρ_{Pl}). **Note.** It is also possible that pBBS to had been actually composed only from up and down quarks: (**1**) half of their number found in hadronic form AND (**2**) half of their number in leptonic single-hadron-mbh highly-compressed form (so that the two forms would NOT react to each other and co-exist as a matter-antimatter "crystalline soup"); **the Big Bang may had actually been a progressive slow decompression of that pBBS explaining the very high uniformity of mass distribution in all directions of OU** (which uniform distribution is otherwise highly improbable in the case of a universe born from a violent hypothetical explosion as currently believed, BUT probably NOT true)

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II. The other statements and redefinitions of this QGR

1. **Statement on the finite tension acting along the length of any 4DPT.** Each 4D Planck tube (**4DPT**) of our universe (**OU**) is stated to have an inner tension T_{PT} acting along its 3DHS (applied longitudinally on its finite/infinite length and tending to depart the ends of that 4DPT even further to one-another) equal to the Planck force $\left(F_{Pl}\right)$ so that:

$$\boxed{T_{PT} = T_{PT(\max)} \overset{estim.}{=} F_{Pl}\left(= c^4 / G \cong 1.21\times10^{44} N\right)}.$$

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2. **Statement on the finite thickness of any 3DHS of any 4DPT.** Although the thickness of any 3DHS/pe3-brane (of any 4DPT) is stated to may vary (mainly depending on three factors which may stretch or compress that 3DHS or the whole 4DPT [and thus directly or indirectly modify the 3DHS thickness]: (**1**) the inner tension of that 4DPT; (**2**) the waves traveling through that 3DHS; (**3**) the unknown EPs traveling inside that 4DPT), the 3DHS (pe3-brane) of each 4DPT is stated to have a finite thickness ϕ_{HS} with a minimum equal to the Planck length $\left(l_{Pl}\right)$ so that

$$\boxed{\phi_{HS(\min)} \overset{estim.}{=} l_{Pl}\left(= \sqrt{\hbar G / c^3} \cong 1.62\times10^{-35} m\right)}. \quad \textbf{Prediction.}$$

The horizon of any hypothetical closed black hole (**bh**) is also predicted to NOT be actually a zero-thickness surface (which

zero-thickness combined with the holographic principle leads to the paradox of having a finite large mass concentrated on a zero thickness 2D brane, leading to a paradoxal infinite superficial density along any direction of its thickness) BUT to be a bh-horizon possessing a finite and non-infinitesimal thickness $\phi_{HS(min)}$.

3. **The finite elasticity hypothesis (FESTH).** The previous statement (on the finite thickness of any 3DHS of any 4DPT) ALSO implies that any 4DPT (together with our whole 3DS identified with the sum of all 3DHSs of all 4DPTs) has a finite elasticity and can only be "thinned" (by 4DPT longitudinal stretch) up to this minimum thickness $\phi_{HS(min)}$: any attempt to thin any chosen 3DHS (by the elongation of that 4DPT which is assigned that chosen 3DHS) to a thickness lower than $\phi_{HS(min)}$ may transform that 4DPT in a hugely (up to infinitely!) rigid structure that may counteract by recoil. **Predictions**. By using its FESTH, this QGR predicts the existence of a global confinement diameter limit (**GCDL**) of OU: GCSL is defined as that maximum average diameter of OU $d_{OU(max)}$ (that may be reached by global accelerated/decelerated inflation of OU) which may induce general infinite rigidness of all 4DPTs of OU and thus produce a global recoil and deflation of OU: that is how, by using FESTH and GCDL, this QGR predicts a Big Bounce universe (as the standard LQG also co-predicts).

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4. **Statement on the finite massic linear density of any 4DPT**. The positive average massic linear density of any 3DHS/pe3-brane of any 4DPT (**HS/PT**) is stated to be equal to the Planck massic linear density $\left(\rho_{Pl(lin)} = m_{Pl}/l_{Pl} = c^2/G\right)$ so that

$$\rho_{HS/PT} \overset{estim.}{=} \rho_{Pl(lin)}\left(\cong 10^{27}\,kg/m\right):$$ additionally, the negative average massic linear density of any ("empty" suctional) in4thDHV of any 4DPT (**inHV/PT**) PLUS the negative average massic linear density of the average out4thDHV per each 4DPT (**outHV/PT**: defined as the average HV obtained by the division of the total out4thDHV of OU to the total number of 4DPTs of OU) are stated to be equal to $-\rho_{Pl(lin)}$ such as

$$\rho_{inHV/PT} + \rho_{outHV/PT} \overset{estim.}{=} -\rho_{Pl(lin)}\left(\cong -10^{27}\,kg/m\right)$$ and

$$\rho_{HS/PT} + \left(\rho_{inHV/PT} + \rho_{outHV/PT}\right) \overset{estim.}{=} 0\,kg/m;$$ the total average massic linear density of OU per each 4DPT is thus stated to be zero, so that the total mass-energy of OU remains zero.

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5. **Redefinition of both gravitational waves (GWs) and photonic waves (PWs)**. As previously anticipated in this paper, GWs and PWs are both redefined as low amplitude transverse waves traveling on the 3DHS of any 4DPT.

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6. **Redefinition of both the speed of light in vacuum (c) and the speed of gravity in vacuum** $\left(v_g\right)$. By using the simplified Vincenzo Galilei's formula for the maximum speed v_{max} of a wave in a string with massic linear density ρ_{str} tensioned by a

tensional force T_{str} (only valid for low amplitude vibrations as both GWs and PWs are) $\boxed{v_{max} = \sqrt{T_{str}/\rho_{str}}}$, c and v_g are both redefined as the maximum speed of a PW or a GW respectively in a long thin cylindrical string-like 3DHS of any 4DPT (**HS/PT**) with (massic) linear density renotated (for simplicity) as $\rho_{HS} = \rho_{HS/PT}\left(\overset{estim.}{=} \rho_{Pl(lin)}\right)$ tensioned by the force $T_{PT}\left(\overset{estim.}{=} F_{Pl}\right),$ such as:

$$\boxed{v_g \overset{\leq}{\cong} c = v_{max} = \sqrt{T_{PT}/\rho_{HS}}}.$$ In other words, this QGR considers that both c and v_g are actually indirect measures of both T_{PT} and ρ_{HS}, not vice versa!

**

7. **Redefinition of big G**. The universal gravitational constant G is also redefined as a function (and thus an indirect measure) of both T_{PT} and ρ_{HS} (via speed of gravity $v_g \overset{\leq}{\cong} c$), such as

$$\boxed{G \overset{redef.}{=} G_{PT} = v_g{}^2/\rho_{PT}\left(\overset{\leq}{\cong} T_{PT}/\rho_{HS}{}^2\right)}:$$ the Newtonian gravitational attraction force F_g (between to rest masses m_1 and m_2 with average size $s = \sqrt{s_1 s_2}$ found at distance $d \gg s$) is also redefined by this QGR as a function of G_{PT} such as

$$\boxed{F_g = \frac{T_{PT}}{\rho_{HS}{}^2}\frac{m_1 m_2}{d^2} = \frac{T_{PT}}{\rho_{HS}{}^2}\frac{m_1}{d}\frac{m_2}{d} = T_{PT}\frac{\rho_1}{\rho_{HS}}\frac{\rho_2}{\rho_{HS}}},\ F_g$$ with being a function of both formal generic massic linear densities $\rho_1 = m_1/d$ and $\rho_2 = m_2/d$ (and their ratios ρ_1/ρ_{HS} and ρ_2/ρ_{HS}), similarly to any two masses being attracted to one another when located on the same tensioned (3D) string. **Explanation (1) (of the relative divergence of big G experimental values)**. The divergence of big G experimental values may be actually explained by the fact that

$$\boxed{G \overset{redef.}{=} f\left(v_g{}^2\right)}$$ so that any variation of v_g would lead to an amplified variation of big G (which varies with the squared v_g). **Explanation (2) (of the acceleration expansion of OU)**. A variable v_g which varies as $v_g - v_x$ (when two masses that attract each other also depart from one another with relative speed v_x while simultaneously interchanging gravitational waves with speed v_g and resultant speed $v_r = v_g - v_x$) may also explain a progressively smaller $\boxed{G \overset{redef.}{=} f\left(v_r{}^2\right) = f\left[\left(v_g - v_x\right)^2\right]}$ which leads to a resultant gravitational force

$$F_{g(r)} = \frac{\left(v_g - v_x\right)^2}{\rho_{PT}} \cdot \frac{m_1 m_2}{r^2}$$

smaller than the expected

$$F_g = \frac{v_g^2}{\rho_{PT}} \cdot \frac{m_1 m_2}{r^2}$$

with the increase of v_x: this weaker-than-expected $F_{g(r)}$ tends to slightly amplify (to values slightly larger than expected) any additional non-gravitational/gravitational force acting on those departing masses and trying to depart those masses from one another; this force-amplification effect is proposed as an explanation for the currently measured accelerated expansion of OU.

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8. Redefinition of the Planck constant (h). The Planck constant (**h**) is also redefined as a function (and thus an indirect measure) of

$$T_{PT}\left(\overset{estim.}{=} F_{Pl}\right), \rho_{HS}\left(\overset{estim.}{=} \rho_{Pl(lin)}\right) \quad \text{and} \quad \phi_{HS}\left(\overset{estim.}{=} l_{Pl}\right)$$

such as $\boxed{h \overset{redef.}{=} h_{PT} = \sqrt{T_{PT} \cdot \rho_{HS} \cdot \left(4\pi^2 \phi_{HS}^4\right)}}$.

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9. Statement on the minimum wave momentum allowed by a vibrating 4DPT. Note that this (redefined) $h(= h_{PT})$ doesn't depend on the (possibly infinite) 4DPT length, but alternatively and specifically depends on its double-squared 3DHS thickness ϕ_{HS}^4: this QGR states that a 4DPT can vibrate down to wavelengths comparable to its 3DHS finite non-zero (and non-infinitesimal) thickness ϕ_{HS}, but not less than ϕ_{HS}, which clearly imposes a minimum momentum $h(= h_{PT})$ that any PT can acquire and carry by its vibration. **Co-statement**. Based on the exponent "4" of ϕ_{HS}^4, this QGR also states that a 4DPT may vibrate in 4 distinct spatial dimensions at once, so that $h\left[= f\left(\phi_{HS}^4\right)\right]$ is also considered an indirect proof for a 4DST, with "time" being modeled as an additional (spatial) 4th D (**4thD**) with compact topology. That minimal (hyper)volume circumscribing a micro-cycle of any wave (traveling on any such PT) $\boxed{V_{PT(min)} = 4\pi^2 \phi_{HS}^4}$ (which defines h by geometrical constraint) is regarded by this QGR as a "hybrid" (hyper)volumic-unit and momentum-unit of a PT, which may be considered a geometrically quantized/"granular" 4DPT of our 4DST. Planck constant is specifically redefined as a function of $\sqrt{V_{PT(min)}}\left(= 2\pi\phi_{HS}^2\right)$ which has the significance of a doubled minimum section area $\boxed{A_{PT(min)} = \pi\phi_{HS}^2}$ (the area of a hypothetical maximally compacted 4DPT possessing only a 3DHS and having a zero inner 4thD hypervolume). **Important note (1)**. The same $\boxed{V_{PT(min)}\left(= 4\pi^2 \phi_{HS}^4\right)}$ determines the minimum action (quantum angular momentum measured by Planck constant h) but also the minimum mass-energy quanta as

shall be explained next. **Important note (2)**. The fact that $h\left[= f\left(\phi_{HS}^4\right)\right]$ is a function of ϕ_{HS} only may also be considered and indirect proof for 4thD being actually an additional dimension with compact topology and NOT a bulk 4th spatial dimension (as EGR wrongly models spacetime).

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10. Explanation of the wave-particle dual/"hybrid" character of all elementary particles (EPs) or non-EPs based on $V_{PT(min)}$. Because any 4DPT has a finite non-zero and non-infinitesimal unit of deformation $V_{PT(min)}$, any wave traveling on any 4DPT will appear as carrying such a $V_{PT(min)}$-unit along the vibrating 4DPT AND that $V_{PT(min)}$-unit can be regarded as the corpuscular character of any wave which is indissolubly related to that wave so that OU only allows wave-particle entities (**wavicles**).

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11. Prediction on the finite non-zero and non-infinitesimal volumes of all elementary particles (EPs) based on $V_{VT(min)}$. Given the existence of $V_{PT(min)}$ (implied by the existence of a finite and non-infinitesimal Planck constant h measuring elementary quantum angular momentum) EPs are thus predicted to NOT be point-like particles (as QFT wrongly models EPs in the present mainstream physics), but quasi-point-like 3D particles (a form of spacetime "bubbles" composed from one or more of these elementary $V_{PT(min)}$ deformation-units of any wave traveling on any 4DPT): in this way, this QGR also solves the infinite self-energy paradox of any EP (a paradox which appears when treating EPs as point-like particles). **Explanation**. Quantum superposition principle (**QSP**) may be also the consequence (and indirect subtle proof) of EPs being actually 4D spacetime (**4DST**) bubbles which superpose all their possible quantum states (measurable in our 3DS) stored in their 4thD "core".

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12. Redefinitions of fermions and bosons. This QGR redefines bosons as open waves traveling on any 4DPT of OU. This QGR also redefines fermions as closed waves traveling on any 4DPT of OU.

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13. Explanation of the equivalence between inertial mass and gravitational mass based on $V_{PT(min)}$. Because $V_{PT(min)}$ is considered an indivisible volumic unit of our 4DST, all physical objects (**POs**) no matter how large or small are definable as being composed from a relatively fixed integer number of $V_{PT(min)}$ volumic units when observed and measured in a sufficiently narrow time frame: the same number of $V_{PT(min)}$-units is stated to react the same if accelerated by gravity or by any other non-gravitational fundamental force.

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14. Redefinition of the hypothetical (hyp) Planck field (hypPF) quantized by the hyp Planck particle (hypPP). HypPF (quantized by hypPP) is redefined by QGR as being actually a scalar 4D Higgs field (**4DHF**) quantized by a 4D Higgs boson (**4DHb**), which 4DHF is defined as the basic permanent vibration of any 4DPT. **Statement on the mass of the 4DHb**. The rest

mass of a 4DHb $\left(m_{4DHb}\right)$ is stated to be equal to the Planck mass $\left(m_{Pl} = \sqrt{\hbar c / G} \cong 1.22 \times 10^{19} GeV/c^2\right)$ such as

$$\boxed{\overset{estim.}{m_{4DHb} = m_{Pl}}}$$: this 4DHb is also assigned (by QGR) the previously defined finite non-zero (and non-infinitesimal) minimum 4D hypervolume $V_{PT(\min)}\left(= 4\pi^2 \phi_{HS}{}^4\right)$ so that:

$$\boxed{V_{4DHb} = V_{PT(\min)} = 4\pi^2 \phi_{HS}{}^4}.$$ For $\rho_{4DHb(lin)}$ to be exactly equal to ρ_{HS} (which is indirectly stated by m_{4DHb} and ρ_{HS} estimations), $V_{4DHb}\left(= V_{PT(\min)}\right)$ should be modeled as a 4D cylinder with minimal length $\boxed{L_{PT(\min)} = \phi_{HS}}$ (so that

$$\boxed{\overset{estim.}{\rho_{4DHb(lin)} \cong m_{4DHb} / L_{PT(\min)} = \rho_{HS}}}$$) and a 3D section maximal hyper-area of a 4DPT (assigned a 3DHS)

$$\boxed{A_{PT(3D)(\max)} = V_{4DHb} / L_{PT(\min)} = 4\pi^2 \phi_{HS}{}^3}:$$ such a cylindrical sectional 3D hyper-area (of a 4DPT) with minimal length $l_{3DHS(\min)}\left(= L_{PT(\min)} = \phi_{HS}\right)$ will have a 2D sectional area of

$$\boxed{A_{PT(2D)(\max)} = A_{PT(3D)(\max)} / l_{3DHS(\min)} = 4\pi^2 \phi_{HS}{}^2}$$ which corresponds to a total (maximal) transverse radius of a 4DPT $\boxed{r_{PT(\max)} = 2\sqrt{\pi}\phi_{HS}}$ so that

$$\boxed{A_{PT(2D)(\max)} = \pi r_{PT(\max)}{}^2 = \pi\left(2\sqrt{\pi}\phi_{HS}\right)^2 = 4\pi^2 \phi_{HS}{}^2}.$$

Predictions. The ratio between the entire maximal transverse radius of a 4DPT and the thickness of its 3DHS is thus predicted to be $\boxed{r_{PT(\max)} / \phi_{HS} = 2\sqrt{\pi} \cong 3.545}$. The ratio between the maximal transverse radius of the "hollow" 4thD "core" of a 4DPT and the thickness of its 3DHS is thus predicted to be $\boxed{\left(r_{PT(\max)} - \phi_{HS}\right)/\phi_{HS} = 2\sqrt{\pi} - 1 \cong 2.545}$.

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15. Statement on the 3D Higgs boson (3DHb) observed and measured in our 3D space (3DS). What we measure as a 3D Higgs boson (**3DHb**) (the quanta of a 3DHF assigned a rest mass $m_{3DHb} \cong 125 GeV/c^2$) in our 3DS is stated by QGR to be actually only that minor fraction of total 4DHF $\boxed{m_{3DHb} / m_{4DHb} \cong 10^{-17}}$ which minimally intersects our 3DS (identified with the sum of all 4DPT-assigned 3DHS). **In other words**, if any wave traveling on any chosen 4DPT induces that "host" 4DPT to vibrate in all 4 dimensions of our 4DST but those vibrations have their higher amplitude in the 4thD (with compact topology), then the largest fraction/percent of the vibrational energy will concentrate in that 4thD and that is why we measure our 3DS vacuum (identified with the 3DHS of that chosen 4DPT)

to have a very low energetic density fraction (when compared to the total energy of the vibration in all 4Ds, especially in the 4thD).

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16. Checkpoint conclusion. c, v_g and big G are all considered by QGR to be in fact indirect measures of $\rho_{4DHb(lin)}\left(= \rho_{HS}\right)$.

Explanation. Because 4DHF dominantly manifests in the 4thD and only minimally in our 3DS, we only measure an average massic density of our observable universe (**ou**) (including the contribution from energy) $\rho_{ou} \cong 9.9 \times 10^{-30} kg/m^3$, which obviously much smaller than the Planck/4DHb massic density.

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