# A cyclic toy model of the universe predesigned for life, based on preonic quantized branes and a very strong 2D gravitational field as a candidate for a unified primordial field

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## Abstract

This paper proposes a cyclic toy model of the universe predesigned for life, based on preonic quantized 1-branes (strings), quantized 2-branes (supermembranes/2D surfaces) and the holographic principle. This toy model is based on a few simple hypothesis/assumptions, including the existence of a universal brane quanta (conceived as a basic quantum clock) for any n-brane and a unified primordial field (**UPF**) defined as equivalent to a very strong 2D gravitational field acting on hypothetical quark/leptonic/bosonic 2-branes.

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## Part I. Brane quantization and a predicted correspondence between baryons and leptons

Any periodic process in our universe which implies discrete/quantized changes of any quantum particle (**QP**) or n-brane can be considered a quantum clock (**QC**), no matter if a full cycle of that periodic process has a fixed or variable time duration $t_{QC}$, which implies a fixed or variable angular frequency $\omega_{QC}$ and a fixed or variable (linear) spatial speed $v_{QC}$ for any QC subcomponent.

**Hypothesis 1 (H1)**. Our universe may not allow an infinitely large or infinitesimally small $\omega_{QC}$ but only a pair of constants $\omega_{\min}, \omega_{\max} \in \mathbb{R} - \{0, 1/\infty, \infty\}(rad/s)$ for all QCs in any moment of evolution of our universe, so that $\omega_{QC} \in [\omega_{\min}, \omega_{\max}]$.

**(1)** H1 also implies the existence of a pair of constant time durations per any full cycle of any QC in our universe $t_{\min}(=1/\omega_{\max}), t_{\max} = (1/\omega_{\min}) \in \mathbb{R} - \{0, 1/\infty, \infty\}(s)$, so that $t_{QC} \in [t_{\min}, t_{\max}]$.

**(2)** H1 also implies the existence of a finite constant time and frequency "ambitus" of our universe $\boxed{N_a (= \omega_{\max}/\omega_{\min} = t_{\max}/t_{\min}) \in \mathbb{R} - \{0, 1/\infty, \infty\}}$.

**Hypothesis 2 (H2)**. Our universe may not allow an infinitely large or infinitesimally small spatial (linear) speed $v_{QC}$ for any of component of its QCs, but only $v_{\min}, v_{\max} \in \mathbb{R} - \{0, 1/\infty, \infty\}(m/s)$, so that $v_{QC} \in [v_{\min}, v_{\max}]$. H2 additionally proposes $\boxed{v_{\max}/v_{\min} \overset{hyp.}{=} N_a}$.

**(1)** H1 and H2 together imply the existence of a pair of linear lengths $l_{\min}(= v_{\min} \cdot t_{\min}), l_{\max}(= v_{\max} \cdot t_{\max}) \in \mathbb{R} - \{0, 1/\infty, \infty\}(m)$, so that ${N_a}^2 (= l_{\max}/l_{\min}) \in \mathbb{R} - \{0, 1/\infty, \infty\}$. ${N_a}^2$ may be regarded as the spatial size "ambitus" of any QC in our universe.

**(2)** In conclusion, $N_a$ can be considered a spacetime global scaling factor of our universe.

**Hypothesis 3 (H3)**. Let us consider a 2D basic clock (**BC**) having the shape of a circle/disk in a 2D (Euclidean) plane with a diameter $d_{BC} = l_{\min}$ containing a (diametric) 1D arrow of length $d_{BC}$ which may spin around its middle point. The arrow of BC can be assigned a finite positive rest mass

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$m_{BC} > 0(kg)$ and a finite positive rest energy $E_{BC} > 0(J)$. The 2D Euclidean plane space swept by the oscillating arrow of that BC may be considered to have a negative rest mass $\left(-m_{BC}\right)$ and a negative energy $\left(-E_{BC}\right)$ so that the total energy of a BC remains zero: in this view, BC is a 2D spacetime clock with two spatial dimensions (in a 2D plane) and one temporal dimension (overlapping the second spatial dimension in which the arrow of that BC oscillates), with two possible time directions. BCs with a clockwise rotating arrow may be assigned a positive sign + and BCs with an anti-clockwise rotating arrow may be assigned a negative sign -: +BCs have arrows that move forward in time (from past to future) and –BCs have arrows that move backwards in time (from future to past).

**(1)** H3 additionally states that BCs may spontaneously pop-up from a 0D vacuum in (+BC,-BC) pairs and may have a variable lifetime $t_{BC} \in \left[t_{\min}, t_{\max}\right]$: in this view, the micro-spacetime of any BC is indissolubly related to the arrow of that BC and cannot exist independently to it, so that it is stated to appear and disappear together with that BC arrow;

**(2)** H3 additionally states that the circumferential distance swept by the head of a BC arrow per each movement is also fixed and equal to $l_{\min}$, so that BCs can execute just 3 movements per each full-cycle of spin, because $\pi l_{\min} - 3l_{\min} < l_{\min}$: with this additional condition, BC becomes a quantum BC which permits only 3 possible configurations per each full cycle of BC arrow spin. This additional condition permits the interconversion between $\omega_{BC}$ and $v_{BC}$, so that: $\boxed{\omega_{BC} = v_{BC} / \left(\pi l_{\min}\right)} \Leftrightarrow \boxed{v_{BC} = \omega_{BC} \cdot \left(\pi l_{\min}\right)}$. BCs can be assigned other additional rules of behavior and interaction that won't be discussed in this paper: for example, the +/- sign (the time direction) and the fixed number of 3 configurations per each spin full-cycle of BCs may be used to define the quantum charge of a BC $\pm q_{BC}$ which only permits fractional multiples of $\pm\frac{1}{3}q_{BC}$.

**(3)** n-branes can be generically defined as groups of BCs in which +BCs predominate; n-antibranes can be generically defined as n-branes in which -BCs predominate, with $n \in \mathbb{N}^*$ being the number of (Euclidean/non-Euclidean) dimensions of any n-brane/antibrane;

**(4)** H3 also states that both spacetime and bosonic/fermionic QPs are 2-branes/antibranes composed from +BCs and –BCs that "live" in eleven dimensions. 2-branes/antibranes are supermembranes exhibiting supersymmetry (a generalization of superstrings proposed by M-Theory). The spacetime 2-brane (which is its own antibrane) is stated to be composed from an (exactly) equal number of +BCs and –BCs. QPs are stated to be 2-branes composed from "evanescent" (+BC,-BC) pairs (which appear and disappear spontaneously from the vacuum) and additional +BCs: their correspondent anti-QPs are stated to be 2-antibranes composed from "evanescent" (+BC,-BC) pairs and additional -BCs. The spacetime 2-brane is complementary to the QP 2-branes/antibranes and is stated to compose our entire observable universe, which is also predicted to contain a total number of +BCs exactly equal to the total number of –BCs.

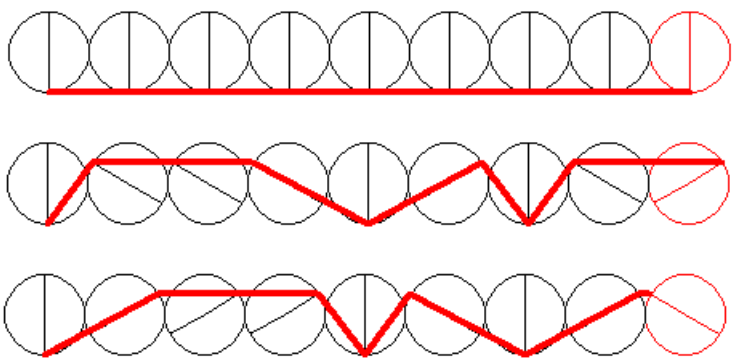

**Figure I-1**. Quantized 1-branes (strings) with oscillations and shapes generated by spinning BC arrows

**(5)** H1, H2 and H3 together may explain the recently demonstrated unattainability principle (aka the 3rd law of thermodynamics) proposed in 1912 by Nernst ("cooling an object to absolute zero is impossible with a finite amount of time and resources.") [**1**], as BCs are hypothesized to not allow zero or infinitesimally small $\omega_{\text{var}}$ and $v_{\text{var}}$ by any means (including cooling).

**Hypothesis 4a (H4a)**. Inspired by the holographic principle (**HP**), H4a states that all quarks ($u, d$; c, $s$; $t, b$) and their correspondent antiquarks ($\bar{u}, \bar{d}$; $\bar{c}, \bar{s}$; $\bar{t}, \bar{b}$) may be defined as **empty spherical (possibly ellipsoidal) closed 2-branes/antibranes with finite positive non-0 radii** $r_{\text{x}} \in \left[ l_{\min}, l_{\max} \right]$: the non-0 rest masses and electromagnetic/weak hyper-/color charges of quarks/antiquarks are stated to be "stored" holographically on their 2D spherical (empty) surfaces. As the up-quark $u$ (which has the smallest rest mass of all the quarks/antiquarks) is the final decay product of all the other quarks (by emitting W/Z bosons), the non-up-quarks/antiquarks can be essentially and generally considered the excited states of the "prototype" up-quark $u$ and its up-antiquark $\bar{u}$ which are hypothesized as basic spherical 2-branes composed from +BCs (which predominate in $u$) and –BCs (which predominate in $\bar{u}$). For simplicity, the standard quarks/antiquarks can be named "**2-quarks/antiquarks**" (analogous to 2-branes/antibranes).

**(1)** H4a is a potential solution to avoid infinite self-energies of the point-like QPs with 0-radii proposed by the quantum field theory.

**(2)** H4a also states that all 2-quarks/antiquarks (which couple with all four fundamental fields) permanently emit all types of virtual (/real) bosons/antibosons (gluons, photons, W/Z bosons and possibly hypothetical gravitons) in the 3D space, bosons/antibosons that may subsequently generate 2-quark-antiquark pairs which pop-up into existence in the same 3D space:

- **a.** the virtual bosons/antibosons emitted in the interior of a 2-quark/antiquark are then reabsorbed in the walls of the same 2-quark/antiquark generating **inner quantum fields (inQFs)** that may explain the non-0 rest masses, the non-0 electromagnetic/weak hyper/color charges and the non-0 spin angular momentums of all 2-quarks/antiquarks (even at rest); the existence inQFs imply that 2-quarks/antiquarks are not really "empty" in the absolute sense, but are actually filled with virtual bosons/antibosons (and possibly 2-quark-antiquark pairs generated by those virtual bosons/antibosons);
- **b.** the virtual bosons/antibosons emitted radially in the exterior space of a 2-quark/antiquark generate **outer quantum fields (outQFs)** with associated forces that are inversely-proportional (in different degrees) to the area of the 2D spherical front of emission, or possibly inversely-proportional to the circumference of a 1D circular front of emission

**Hypothesis 4b (H4b)**. Also inspired by HP (and complementary to H4a), H4b states that all known bosons ($g, \gamma$, $W^+$, $Z^0$ and $H^0$) and their correspondent antibosons ($\bar{g} \equiv g, \bar{\gamma} \equiv \gamma, W^-$, $\bar{Z}^0 \equiv Z^0$ and $\bar{H}^0 \equiv H^0$) may be defined as **open 2-branes/antibranes** (with possibly plane-like or curved cylinder/cone/troncone-like partially/fully open shapes): in this view, the known bosons/antibosons may be generically called **2-bosons/antibosons (2-gluons, 2-photons etc)**.

**(1)** 2-bosons/antibosons permanently and perpetually generate virtual 2-quark-antiquark pairs which pop-up from the 2-bosonic surfaces into the 3D space.

**(2)** The fully-open 2-branes/antibranes may explain why some 2-bosons (like the 2-gluons and the 2-photons) have zero rest masses or possibly very small non-0 rest masses (and only/almost entirely relativistic/kinetic masses). The 2-quark-antiquark pairs that pop-up from their (fully opened) 2D surfaces in the 3D space become almost fully lost in that 3D space generating outQFs (and being reabsorbed by other quantum particles): however, it is almost sure that a very small percent of those virtual 2-quark-antiquark pairs emitted in the 3D adjacent space of those 2-bosons/antibosons may be quickly reabsorbed in the "walls" of that same 2-bosons/antibosons and so generating small inQFs which may explain possible very small (but non-zero) rest masses

"hidden" in the total relativistic energies of those 2-bosons/antibosons (as some theories predict). However, that very large percent of 2-quark-antiquark pairs that escape that bosonic fully-open 2-brane (like the 2-gluon and the 2-photon are) in the 3D space generates powerful outQFs (like the strong nuclear field [**SNF**] mediated by 2-gluons and the electromagnetic field [**EMF**] mediated by 2-photons) that loses its strength radially and inverse-proportionally to a 2D spherical emission front or possibly a 1D circular emission front.

**(3)** The partially-open (cylinder/cone/troncone-like) shapes may explain why some 2-bosons/antibosons (like the 2-W/Z bosons and the 2-Higgs boson) may have very large non-zero rest masses: the 2-quark-antiquark pairs that pop-up from their 2D surfaces in the 3D space may be quickly (at least partially) reabsorbed (in a potential large percent) in the "walls" of those same bosonic 2-branes, generating possibly strong inQFs which may explain those large non-zero rest masses; the (possibly) small percent of 2-quark-antiquark pairs that escape those bosonic 2-branes (like the 2-W/Z bosons and the 2-Higgs boson) into the 3D space generate outQFs with associated forces that rapidly lose their magnitude with distance, as those few emitted 2-quark-antiquark pairs quickly reach almost zero density of spread in that 3D space: this is the case of the weak nuclear field (**WNF**) and Higgs field (**HGF**).

**Hypothesis 4c (H4c)**. "Pushing" HP to its limits, H4c speculates that each known 2-quark/antiquark may have a **correspondent closed circular/ellipsoidal empty 1-brane/antibrane (string/antistring) (one-to-one/bijective correspondence) with the same flavor and electromagnetic charge quantity as its 2-quark correspondent (but not the same rest mass, color and spin),** which may be called, for simplicity, a "**1-quark/antiquark"** and noted using under-bars, such as: $\underline{u}$ (1-up-quark with charge $+(2/3)e$), $\underline{\bar{u}}$ (1-up-antiquark with charge $-(2/3)e$), $\underline{d}$ (1-down-quark with charge $-(1/3)e$), $\underline{\bar{d}}$ (1-down-antiquark with charge $+(1/3)e$); $\underline{c}$ (1-charm-quark with charge $+(2/3)e$), $\underline{\bar{c}}$ (1-charm-antiquark with charge $-(2/3)e$), $\underline{s}$ (1-strange-quark with charge $-(1/3)e$), $\underline{\bar{s}}$ (1-strange-antiquark with charge $+(1/3)e$); $\underline{t}$ (1-top-quark with charge $+(2/3)e$), $\underline{\bar{t}}$ (1-top-antiquark with charge $-(2/3)e$), $\underline{b}$ (1-bottom-quark with charge $-(1/3)e$), $\underline{\bar{b}}$ (1-bottom-antiquark with charge $+(1/3)e$);

**(1)** $\underline{u}$ (and $\underline{\bar{u}}$) may be considered basic/prototype closed circular 1-quark/antiquark, so that all the other 1-quarks/antiquarks to be regarded as excited states of $\underline{u}$ and $\underline{\bar{u}}$; as $\underline{u}$ and $\underline{d}$ are both closed 1-branes, they may be considered alternative states of the same "primordial" 1-quark which may be called "**P-quark**" (which may be composed from +BCs only): all the other 1-quarks may be considered excited states of the same P-quark; as $\underline{\bar{u}}$ and $\underline{\bar{d}}$ are both closed 1-antibranes, they may be considered alternative states of the same "primordial" 1-antiquark which may be called "**P-antiquark**" (which may be composed from -BCs only): all the other 1-antiquarks may be considered excited states of the same P-antiquark;

**(2)** 1-quarks/antiquarks are stated by H4c to exist in groups of two, three or more, in a 2D space, analogously to 2-quarks/antiquarks (forming mesons, baryons, tetraquarks, pentaquarks etc, which are all groups of 2-quarks/antiquarks manifesting in the 3D space);

**Hypothesis 4d (H4d)**. "Pushing" HP to its limits, H4d speculates that each known 2-boson/antiboson (or at least the 2-gluon and 2-photon) may **have a correspondent open 1-brane/antibrane (string/antistring) (one-to-one/bijective correspondence)**, which may be called, for simplicity, **1-boson/antiboson** and noted using under-bars, such as: $\underline{g}$ (1-gluon, which is equivalent to the 1-

antigluon $\underline{\bar{g}}$), $\underline{\gamma}$ (1-photon, which is equivalent to the 1-antiphoton $\underline{\bar{\gamma}}$), $\underline{W}^+$, $\underline{W}^- \equiv \underline{\bar{W}}^+$, $\underline{Z}^0 \equiv \underline{\bar{Z}}^0$ and $\underline{H}^0 \equiv \underline{\bar{H}}^0$;

**(1)** $\underline{g} \equiv \underline{\bar{g}}$ may be considered basic/prototype open 1-boson/antiboson, so that all the other 1-bosons/antibosons (including the 1-photons) may be regarded as excited states of $\underline{g} \equiv \underline{\bar{g}}$;

**(2)** As $\underline{g} \equiv \underline{\bar{g}}$ and $\underline{\gamma} \equiv \underline{\bar{\gamma}}$ are both open 1-branes, they may be considered alternative states of the same "primordial" 1-boson (which is its own antiparticle and may be called "**P-boson**"), which may be composed from +/-BCs in equal numbers: all the other 1-bosons/antibosons may be considered excited and possibly asymmetrical states of the same P-boson;

**(3)** The P-boson mediate a field which may be called "**the unified primordial field (UPF)**", as it is a potential candidate for a unified field of all the four fundamental interactions (SNF, WNF, EMF and GF) on a 2D holographic surface (2-brane); UPF may have a strength with many orders of magnitude larger than SNF strength at the Planck scale, so that it may have a coupling constant much larger than 1 at those scales;

**Hypothesis 5 (H5)**. Analogously to hadrons (composed from groups of two, three or more 2-quarks/antiquarks interchanging virtual/real 2-bosons in a compact finite non-0 sub-volume of the 3D space), **leptons may be "2D-hadrons"**: **closed empty spherical (possibly ellipsoidal) 2-branes with positive non-zero radii, composed from 1-quarks/antiquarks (essentially P-quarks/antiquarks) interchanging virtual/real 1-bosons, all these confined on those spherical closed leptonic 2-branes**. In this view, 1-quarks/antiquarks can be considered **preons (including antipreons)**.

**(1)** H5 also states that leptons permanently and perpetually emit 1/2-quark-antiquark pairs which may pop-up into the 3D space in two distinct ways:
- **a.** into the interior 3D space of those (apparently empty) leptons (and then reabsorbed in the "walls" of the same leptons) generating inQFs that may explain the non-zero rest masses/energies and electromagnetic charges (like in the charged leptons);
- **b.** into the exterior 3D space of those leptons, generating outQFs;

**(2)** As 1-quarks/antiquarks mainly interchange 1-gluons on these leptonic spherical 2-branes, UPF manifests at this level as a **2D strong gravitational field** (**SGF**) (mediated by the P-bosons acting on P-quarks/antiquarks) which generates and stabilizes these leptonic 2-branes. The huge strength of the SGF-like UPF (much greater than the SNF strength) may explain why leptons appear as apparently point-like elementary (indivisible) QPs which may keep an almost perfect spherical shape even at relativistic speeds, like the electron was proved to have **[2,3]**.
- **a.** The strength magnitude of the SGF-like UPF probably varies inverse-proportionally to the circumference $2\pi r$ on which 1-bosons spread on the leptonic 2-branes.
- **b.** 1-gluons (P-bosons) are stated to couple with all the other 1D and 2D QPs (1-quarks/antiquarks, 2-quarks/antiquarks and 2-bosons) so that:
  - i. P-bosons may manifest on leptonic 2-branes generating the SGF-like UPF;
  - ii. P-bosons may also manifest in the 3D space, so that **the hypothetical P boson is a candidate for the hypothetical graviton and gravity may be interpreted as a residual UPF** generated by those few P-bosons that manage to escape quark and leptonic 2-branes in a very low density per unit of spherical front area;

**(3)** H5 states that 1-quarks/antiquarks cannot emit or absorb 2-gluons and that is why they do not couple with the strong nuclear field (**SNF**).

**(4)** H5 essentially states (and predicts) a one-to-one (bijection) correspondence between all (or at least the main) hadrons and all the known leptons in the Standard Model (**SM**). Starting from the main baryons (which are the main dominant hadrons in our universe), H5 predicts their correspondent leptons with empty 2D spherical shapes: **see the next table**.

| **Table I-1**. The correspondence between the main baryons and the all the known leptons (predicted as 2D holographic "baryons") | |
|---|---|
| **BARYON (including antibaryon)** | **(correspondent) LEPTON (including antilepton)** |
| **The proton** | **The charged antileptons (antielectron/positron, antimuon, antitauon)** |
| $uud^{(+e)} = proton\left(p^{+}\right)$ | $\underline{u}\underline{u}\underline{d}^{(+e)} = \boxed{2D\ proton = positron\left(e^{+}\right)}$ |
| $\uparrow uud^{(+e)} = excited\ \ p^{+}\left(\uparrow p^{+}\right)$ | $\uparrow \underline{u}\underline{u}\underline{d}^{(+e)} = \boxed{excited\ e^{+}\left(\uparrow e^{+}\right)} = \boxed{antimuon\left(\bar{\mu}^{+}\right)}$ |
| $\uparrow\uparrow uud^{(+e)} = superexcited\ \ p^{+}\ \left(\uparrow\uparrow p^{+}\right)$ | $\uparrow\uparrow \underline{u}\underline{u}\underline{d}^{(+e)} = \boxed{superexcited\ e^{+}\left(\uparrow\uparrow e^{+}\right)} = \boxed{antitauon\left(\bar{\tau}^{+}\right)}$ |
| **The antiproton** | **The charged leptons (electron, muon, tauon)** |
| $\bar{u}\bar{u}\bar{d}^{(-e)} = \boxed{antiproton\left(p^{-}\right)}$ | $\underline{\bar{u}}\underline{\bar{u}}\underline{\bar{d}}^{(-e)} = \boxed{2D\ antiproton} = \boxed{electron\left(e^{-}\right)}$ |
| $\uparrow \bar{u}\bar{u}\bar{d}^{(-e)} = \boxed{excited\ \ p^{-}\left(\uparrow p^{-}\right)}$ | $\uparrow \underline{\bar{u}}\underline{\bar{u}}\underline{\bar{d}}^{(-e)} = \boxed{excited\ e^{-}\left(\uparrow e^{-}\right)} = \boxed{muon\left(\mu^{-}\right)}$ |
| $\uparrow\uparrow \bar{u}\bar{u}\bar{d}^{(-e)} = \boxed{superexcited\ \ p^{-}\left(\uparrow\uparrow p^{-}\right)}$ | $\uparrow\uparrow \underline{\bar{u}}\underline{\bar{u}}\underline{\bar{d}}^{(-e)} = \boxed{superexcited\ e^{-}\left(\uparrow\uparrow e^{-}\right)} = \boxed{tauon\left(\tau^{-}\right)}$ |
| **The neutron** | **The neutrinos (electron neutrino, muon neutrino and tauon neutrino)** |
| $udd^{(0e)} = \boxed{neutron\left(n^{0}\right)}$ | $\underline{u}\underline{d}\underline{d}^{(0e)} = \boxed{2D\ neutron} = \boxed{electron\ neutrino\left(\nu_{e}\right)}$ |
| $\uparrow udd^{(0e)} = \boxed{excited\ \ n^{0}\left(\uparrow n^{0}\right)}$ | $\uparrow \underline{u}\underline{d}\underline{d}^{(0e)} = \boxed{excited\ 2D\ neutron} = \boxed{muon\ neutrino\left(\nu_{\mu}\right)}$ |
| $\uparrow\uparrow udd^{(0e)} = \boxed{superexcited\ \ n^{0}\left(\uparrow\uparrow n^{0}\right)}$ | $\uparrow\uparrow \underline{u}\underline{d}\underline{d}^{(0e)} = \boxed{superexcited\ 2D\ neutron} = \boxed{tau\ neutrino\left(\nu_{\tau}\right)}$ |
| **The antineutron** | **The antineutrinos (electron antineutrino, muon antineutrino and tauon antineutrino)** |
| $\bar{u}\bar{d}\bar{d}^{(0e)} = \boxed{antineutron\left(\bar{n}^{0}\right)}$ | $\underline{\bar{u}}\underline{\bar{d}}\underline{\bar{d}}^{(0e)} = \boxed{2D\ antineutron} = \boxed{electron\ antineutrino\left(\bar{\nu}_{e}\right)}$ |
| $\uparrow \bar{u}\bar{d}\bar{d}^{(0e)} = \boxed{excited\ \ \bar{n}^{0}\left(\uparrow \bar{n}^{0}\right)}$ | $\uparrow \underline{\bar{u}}\underline{\bar{d}}\underline{\bar{d}}^{(0e)} = \boxed{excited\ 2D\ antineutron} = \boxed{muon\ antineutrino\left(\bar{\nu}_{\mu}\right)}$ |
| $\uparrow\uparrow \bar{u}\bar{d}\bar{d}^{(0e)} = \boxed{superexcited\ \ \bar{n}^{0}\left(\uparrow\uparrow \bar{n}^{0}\right)}$ | $\uparrow\uparrow \underline{\bar{u}}\underline{\bar{d}}\underline{\bar{d}}^{(0e)} = \boxed{superexcited\ 2D\ antineutron} = \boxed{tau\ antineutrino\left(\bar{\nu}_{\tau}\right)}$ |

**(5)** H5 predicts that the electron may also have an alternative structure $e^{-} = \underline{d}\underline{d}\underline{d}^{(-e)}$ so that there may be actually two types of electrons possibly indistinguishable from each other: $e^{-}_{1} = \underline{\bar{u}}\underline{\bar{u}}\underline{\bar{d}}^{(-e)}$ and $e^{-}_{2} = \underline{d}\underline{d}\underline{d}^{(-e)}$.

**(6)** H5 predicts that the positron may also have an alternative structure $e^{+} = \underline{\bar{d}}\underline{\bar{d}}\underline{\bar{d}}^{(+e)}$ so that there may be actually two types of positrons possibly indistinguishable from each other: $e^{+}_{1} = \underline{u}\underline{u}\underline{d}^{(+e)}$ and $e^{+}_{2} = \underline{\bar{d}}\underline{\bar{d}}\underline{\bar{d}}^{(+e)}$.

**(7)** H5 predicts the existence of a super-positron with charge $+2e$ $e^{2+} = \underline{u}\underline{u}\underline{u}^{(+2e)}$ and a super-electron with charge $-2e$ $e^{2-} = \underline{\bar{u}}\underline{\bar{u}}\underline{\bar{u}}^{(-2e)}$.

**(8)** H5 describes the $\beta^-$ beta-decay of a 2-down-quark (which may occur in a free or intranuclear neutron, with the emission of a virtual $W^-$ *boson* which further decays into an electron + electron antineutrino), such as:

$$d^{(-1/3e)} \overset{\substack{charge\\conservation}}{\rightarrow} u^{(+2/3e)} + virtual\ W^{(-1e)} \rightarrow u^{(+2/3e)} + \boxed{\substack{(2D-antiproton)\\ \underline{\bar{u}\bar{u}\bar{d}}\\ (electron)}} + \boxed{\substack{(2D-antineutron)\\ \underline{\bar{u}\bar{d}\bar{d}}\\ (electron\\ antineutrino)}}$$

**a.** H5 suggests that the virtual $W^-$ *boson* is in fact a group of six 1-antiquarks $W^- = \underline{\bar{u}\bar{u}\bar{u}\bar{d}\bar{d}\bar{d}}^{(-e)}$ which decomposes asymmetrically in an electron $e^- = \underline{\bar{u}\bar{u}\bar{d}}^{(-e)}$ and an electron antineutrino $\bar{\nu}_e = \underline{\bar{u}\bar{d}\bar{d}}^{0e}$.

**b.** H5 also predicts that $W^- = \underline{\bar{u}\bar{u}\bar{u}\bar{d}\bar{d}\bar{d}}^{(-e)}$ can also decompose asymmetrically in a super-electron $e^{2-} = \underline{\bar{u}\bar{u}\bar{u}}^{(-2e)}$ and a positron $e^+_2 = \underline{\bar{d}\bar{d}\bar{d}}^{(+e)}$.

**(9)** H5 describes the $\beta^+$ beta-decay of a 2-up-quark (which only occurs in an intranuclear proton, with the emission of a virtual $W^+$ *boson* which further decays into a positron + electron neutrino), such as:

$$u^{(+2/3e)} \overset{\substack{charge\\conservation}}{\rightarrow} d^{(-1/3e)} + virtual\ W^{(+1e)} \rightarrow d^{(-1/3e)} + \boxed{\substack{(2D-proton)\\ \underline{uud}\\ (positron)}} + \boxed{\substack{(2D-neutron)\\ \underline{udd}\\ (electron\\ neutrino)}}$$

**a.** H5 suggests that the virtual $W^+$ *boson* is in fact a group of six 1-quarks $W^+ = \underline{uuuddd}^{(+e)}$ which decomposes asymmetrically in a positron $e^+ = \underline{uud}^{(+e)}$ and an electron neutrino $\nu_e = \underline{udd}^{(0e)}$.

**b.** H5 also predicts that $W^+ = \underline{uuuddd}^{(+e)}$ can also decompose asymmetrically in a super-positron $e^{2+} = \underline{uuu}^{(+2e)}$ and an electron $e^+_2 = \underline{\bar{d}\bar{d}\bar{d}}^{(+e)}$.

**(10)** Given the definitions $W^+ = \underline{uuuddd}^{(+e)}$ and $W^- = \underline{\bar{u}\bar{u}\bar{u}\bar{d}\bar{d}\bar{d}}^{(-e)}$, H5 also proposes the neutral Z boson to be defined as $Z^0 = \underline{uuddddd}^{(0e)}$ so that it is equivalent to its own antiparticle $\bar{Z}^0 = \underline{\bar{u}\bar{u}\bar{d}\bar{d}\bar{d}\bar{d}}^{(0e)}$.

**a.** H5 predicts that $Z^0 = \underline{uuddddd}^{(0e)}$ and its excited states can decompose symmetrically in two electron/muon/tauon neutrinos $(\uparrow)(\uparrow\uparrow)\underline{udd}^{(0e)}$.

**b.** H5 also predicts that $Z^0 = \underline{uuddddd}^{(0e)}$ can decompose asymmetrically to a positron $e^+_1 = \underline{uud}^{(+e)}$ and an electron $e^+_2 = \underline{\bar{d}\bar{d}\bar{d}}^{(+e)}$.

**c.** H5 predicts that $\bar{Z}^0 = \underline{\bar{u}\bar{u}\bar{d}\bar{d}\bar{d}\bar{d}}^{(0e)}$ and its excited states can decompose symmetrically in two electron/muon/tauon antineutrinos $(\uparrow)(\uparrow\uparrow)\underline{\bar{u}\bar{d}\bar{d}}^{(0e)}$;

**d.** H5 also predicts that $\bar{Z}^0 = \underline{\bar{u}\bar{u}\bar{d}\bar{d}\bar{d}\bar{d}}^{(0e)}$ can decompose asymmetrically to an electron $e^-_1 = \underline{\bar{u}\bar{u}\bar{d}}^{(-e)}$ and a positron $e^+_2 = \underline{\bar{d}\bar{d}\bar{d}}^{(+e)}$;

**(11)** H5 predicts that the 2-photon is also a group of six 1-quarks/antiquarks of four types which may convert to one another by $\underline{u} \leftrightarrow \underline{d}$ and $\underline{\bar{u}} \leftrightarrow \underline{\bar{d}}$ interconversions, each type generating a

different decay pair, depending on the excitation level of the 1-quarks composing those photons:

**a.** $\gamma_1 = \underline{u}\underline{u}\underline{u}\overline{\underline{u}}\overline{\underline{u}}\overline{\underline{u}}^{(0e)}$ (its own antiparticle) which may decay into a super-positron $e^{2+} = \underline{u}\underline{u}\underline{u}^{(+2e)}$ and a super-electron $e^{2-} = \overline{\underline{u}}\overline{\underline{u}}\overline{\underline{u}}^{(-2e)}$;

**b.** $\gamma_2 = \underline{u}\underline{u}\underline{d}\overline{\underline{u}}\overline{\underline{u}}\overline{\underline{d}}^{(0e)}$ (its own antiparticle) which may decay into a positron $e^{+}(+1/2) = \underline{u}\underline{u}\underline{d}^{(+e)}$ and an electron $e^{-}(+1/2) = \overline{\underline{u}}\overline{\underline{u}}\overline{\underline{d}}^{(-e)}$;

**c.** $\gamma_3 = \underline{u}\underline{d}\underline{d}\overline{\underline{u}}\overline{\underline{d}}\overline{\underline{d}}^{(0e)}$ (its own antiparticle) which may decay into an electron/muon/tauon neutrino $(\uparrow)(\uparrow\uparrow)\underline{u}\underline{d}\underline{d}^{(0e)}$ and an electron/muon/tauon antineutrino $(\uparrow)(\uparrow\uparrow)\overline{\underline{u}}\overline{\underline{d}}\overline{\underline{d}}^{(0e)}$.

**d.** $\gamma_4 = \underline{d}\underline{d}\underline{d}\overline{\underline{d}}\overline{\underline{d}}\overline{\underline{d}}^{(0e)}$ (its own antiparticle) which may decay into an electron $e^{-}_{(-1/2)} = \underline{d}\underline{d}\underline{d}^{(-e)}$ and a positron $e^{+}_{(-1/2)} = \overline{\underline{d}}\overline{\underline{d}}\overline{\underline{d}}^{(+e)}$.

**(12)** As the Higgs boson $H^0$ was observed to decay into two W bosons or two Z bosons, H5 predicts that $H^0$ may be actually a group of twelve 1-quarks/antiquarks and may be its own antiparticle such as: $H^0 = (\underline{u}\underline{u}\underline{u}\underline{u})(\underline{d}\underline{d}\underline{d}\underline{d})(\underline{d}\underline{d}\underline{d}\underline{d})^{(0e)}$, $\overline{H}^0 = (\overline{\underline{u}}\overline{\underline{u}}\overline{\underline{u}}\overline{\underline{u}})(\overline{\underline{d}}\overline{\underline{d}}\overline{\underline{d}}\overline{\underline{d}})(\overline{\underline{d}}\overline{\underline{d}}\overline{\underline{d}}\overline{\underline{d}})^{(0e)}$

**(13)** H5 also states that it is plausible for 2-quarks/antiquarks to be actually groups of two 1-quarks/antiquarks, such as: $u = \overline{\underline{d}}\overline{\underline{d}}^{(+2e/3)}$, $\overline{u} = \underline{d}\underline{d}^{(-2e/3)}$, $\overline{d} = \underline{u}\underline{d}^{(+e/3)}$ and $d = \overline{\underline{u}}\overline{\underline{d}}^{(-e/3)}$ (the same for the charm, strange, top, bottom quark flavors: $c = \overline{\underline{s}}\overline{\underline{s}}^{(+2e/3)}$, $\overline{c} = \underline{s}\underline{s}^{(-2e/3)}$ etc).

**a.** The "compression" of $u$ to $\underline{u}$ implies the conversion of $\overline{\underline{d}}\overline{\underline{d}}^{(+2e/3)}$ to $\underline{u}$, which is essentially a fusion between two $\overline{\underline{d}}$;

**b.** The compression of a proton $p^{+} = uud^{(+e)} = (\overline{\underline{d}}\overline{\underline{d}})(\overline{\underline{d}}\overline{\underline{d}})(\overline{\underline{u}}\overline{\underline{d}})$ to a positron $e^{+} = \underline{u}\underline{u}\underline{d}^{(+e)}$ implies two fusions $(\overline{\underline{d}}\overline{\underline{d}}) \rightarrow \underline{u}$ and a fusion $(\overline{\underline{u}}\overline{\underline{d}}) \rightarrow \underline{d}$: the energy excess produced by these three fusions is probably converted in the P-bosons that mediate the SGF-like UPF, which is so powerful that it manages to compress a hadron (like to proton/antiproton and the neutron/antineutron) to a lepton (leptonic 2-brane) with a mass contraction rate (mass "defect") varying from ~99.9% (as the leptons like the electron/positron are ~1840 times lighter than their correspondent hadrons: the proton and antiproton) up to ~$10^{10}$ (as the leptons like neutrinos/antineutrino are probably ~$10^{10}$ times lighter than their correspondent hadrons [the neutron and the antineutron].

**(14)** H5 also states that it is very plausible for 2-gluons to be actually groups of four 1-quarks/antiquarks composed from subgroups of 1-quark/antiquarks pairs (similar to photons), such as: $g_1 = \underline{u}\underline{u}\overline{\underline{u}}\overline{\underline{u}}^{(0e)}$, $g_2 = \underline{u}\underline{d}\overline{\underline{u}}\overline{\underline{d}}^{(0e)}$, $g_3 = \underline{d}\underline{d}\overline{\underline{d}}\overline{\underline{d}}^{(0e)}$; $g_4 = \underline{c}\underline{c}\overline{\underline{c}}\overline{\underline{c}}^{(0e)}$, $g_5 = \underline{c}\underline{s}\overline{\underline{c}}\overline{\underline{s}}^{(0e)}$, $g_6 = \underline{s}\underline{s}\overline{\underline{s}}\overline{\underline{s}}^{(0e)}$; $g_7 = \underline{t}\underline{t}\overline{\underline{t}}\overline{\underline{t}}^{(0e)}$, $g_8 = \underline{t}\underline{b}\overline{\underline{t}}\overline{\underline{b}}^{(0e)}$, $g_9 = \underline{b}\underline{b}\overline{\underline{b}}\overline{\underline{b}}^{(0e)}$;

**(15)** H5 may offer an elegant solution to the apparent dominance of matter over antimatter in the present universe, by stating that antimatter is in fact "hidden under our noses" as confined in (2D) leptonic spherical holograms (leptonic 2-branes), so that matter-to-antimatter quantitative ratio in our universe is actually 1:1.

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## Part II. The prediction of the finite positive non-0 radii of all known 2-quarks/antiquarks and all leptons/antileptons

**Prediction 1 (P1)**. H5 predicts that all physical quantities used to describe 2-quarks and leptons (electromagnetic/weak hyper-/color charges, non-0 rest masses etc) essentially have 2D (surface) densities and 1D (linear) densities implicitly. For example, the predicted finite positive non-zero radius of the positron/electron $r_e$ can be estimated using: the rest mass of the proton $\left(m_p\right)$, the rest mass of the positron (2D-proton) $\left(m_e\right)$, the radius of the proton $r_p \cong 0.87\,fm$ and its volume $V_p = 4\pi {r_p}^3/3$.

**(1)** The proton volumic density is $\left(\rho_{p(3D)} = m_p / V_p\right) \cong 6.064\times10^{17}\,kg/m^3$, so that an imaginary proton/antiproton with a spherical volume of $1m^3$ will have an imaginary mass $M_p \cong 6.064\times10^{17}\,kg$ and a spherical area of $A_p = 4\pi\left[1m^3/(4\pi/3)\right]^{2/3} \cong 4.836m^2$ (the area of a sphere with a volume of $1m^3$). If the entire rest mass $M_p$ of this imaginary proton/antiproton would be compressed on the 2D surface of this sphere with $A_p = 4.836m^2$, the 2D superficial density of this resulting 2D-proton/antiproton (an imaginary positron/electron) would be $\left(\rho_{p(2D)} = M_p / A_p\right) \cong 1.254\times10^{17}\,kg/m^2$. A positron/electron with a 2D superficial density $\rho_{e(2D)} = m_e/\left(4\pi {r_e}^2\right)$ equal to $\rho_{p(2D)}$ would have a non-0 finite radius $r_e^{\,estim.} = \sqrt{m_e/\left(4\pi\rho_{p(2D)}\right)} \cong 7.6\times10^{-25}m$, which is with approximately 2 orders of magnitude smaller than the upper limit $\cong 10^{-22}m$ of the electron radius established by using Penning traps [**4**].

**Hypothesis 6 (H6)**. Interestingly, the ratio $r_e / l_{Pl}^{\,estim.} \cong 4.704\times10^{10}$ (between the predicted electron/positron radius $r_e \cong 7.6\times10^{-25}m$ and the Planck length $l_{Pl} = \sqrt{\hbar G/c^3} \cong 1.62\times10^{-35}m$) is very close to the ratio $\left[\alpha\hbar c/\left(G{m_e}^2\right)\right]^{1/4} \cong 4.518\times10^{10}$, with $\alpha = k_e {q_e}^2/\hbar c \cong 1/137.036$ being the fine structure constant (**FSC**) at rest. H6 states that this closeness may not be a simple coincidence and proposes a plausible candidate for a general empirical function which predicts the non-0 radii of all 2-quarks/antiquarks and all known leptons/antileptons, such as:

$$\boxed{r_L\left(m_x\right) = \left(\frac{\alpha\hbar c}{G{m_x}^2}\right)^{1/4}\cdot l_{Pl}} \Leftrightarrow \boxed{r_L\left(m_x\right) = \left(\frac{\alpha\hbar^3 G}{{m_x}^2 c^5}\right)^{1/4}} \qquad \textbf{(II-1a/1b)}$$

**(1)** $r_L\left(m_x\right)$ for 2-quarks/antiquarks and leptons/antileptons has its values in the interval $\left(10^{-27},10^{-21}\right)m$ with a maximum in the case of neutrinos/antineutrinos and a minimum in the case of the 2-top-quark/antiquark. Interestingly, the values of $r_L\left(m_x\right)$ for 2-quarks/antiquarks and leptons/antileptons "concentrate" around the exponential middle $\cong 10^{-25}m$ between

$l_{Pl} \cong 1.6 \times 10^{-35} m$ and the proton radius $r_p \cong 0.87 \times 10^{-15} m$, with $r_e = r_L(m_e)$ being the almost exact exponential middle of the interval $(l_{Pl}, r_p)$ so that $r_e / l_{Pl} \cong r_p / r_e \cong 10^{10}$. S**ee the next table.**

| **Table II-1. The approximate predicted radii $r_L(m_x)$ of all known quarks and leptons with non-0 rest masses** | |
|---|---|
| **(2D-)lepton/antilepton / 2D-quark/antiquark** | $r_x \cong \frac{r_L(m_x)}{10^{-26} m}$ |
| Generic neutrino/anti-neutrino with $m_{nn} \underset{generic}{\overset{estim.}{\cong}} 0.3 eV / c^2$ | $r_{nn} \cong 95\ 296$ |
| electron/positron $(m_e)$; muon/antimuon $(m_m)$; tauon/antitauon $(m_t)$ | $r_e \cong 73;\ r_m \cong 5;\ r_t \cong 1$ |
| up-quark/antiquark $(m_{uq})$; down-quark/antiquark $(m_{dq})$ | $r_{uq} \cong 34;\ r_{dq} \cong 24$ |
| strange-quark/antiquark $(m_{sq})$; charm-quark/antiquark $(m_{cq})$ | $r_{sq} \cong 5.3;\ r_{cq} \cong 1.5$ |
| bottom-quark/antiquark $(m_{bq})$; top-quark/antiquark $(m_{tq})$ | $r_{bq} \cong 0.8;\ r_{tq} \cong 0.1$ |

**(2)** The dimensionless function $n_x(m_x) = \frac{r_L(m_x)}{l_{Pl}} = \left(\frac{\alpha \hbar c}{G m_x^{\,2}}\right)^{1/4} = \left(\frac{k_e q_e^{\,2}}{G m_x^{\,2}}\right)^{1/4}$, is proposed as a (geometric) scaling factor for all 2-quarks/antiquarks and leptons.

**(3)** Interestingly, the generic $n_x(m_x)$ is also a function of the square root of the generic 2D-quark/lepton mass $m_x^{1/2}$, which may permit the "translation" of all the Koide-like coincidences in specific radius terms $r_x = n_x(m_x) \cdot l_{Pl}$, such as:

$$\frac{m_e + m_m + m_t}{\left(\sqrt{m_e} + \sqrt{m_m} + \sqrt{m_t}\right)^2} \cong \frac{2}{3} \Leftrightarrow \frac{r_e^{\,2} r_m^{\,2} + r_e^{\,2} r_t^{\,2} + r_m^{\,2} r_t^{\,2}}{\left(r_e r_m + r_e r_t + r_m r_t\right)^2} \cong \frac{2}{3} \Leftrightarrow \frac{r_e^{\,2} r_m r_t + r_e r_m^{\,2} r_t + r_e r_m r_t^{\,2}}{r_e^{\,2} r_m^{\,2} + r_e^{\,2} r_t^{\,2} + r_m^{\,2} r_t^{\,2}} \cong \frac{1}{4} \quad \textbf{(II-2a/b/c)}$$

$$\frac{m_{cq} + m_{bq} + m_{tq}}{\left(\sqrt{m_{cq}} + \sqrt{m_{bq}} + \sqrt{m_{tq}}\right)^2} \cong \frac{2}{3} \Leftrightarrow \frac{n_{cq}^{\,-2} + n_{bq}^{\,-2} + n_{tq}^{\,-2}}{\left(n_{cq}^{\,-1} + n_{bq}^{\,-1} + n_{tq}^{\,-1}\right)^2} \cong \frac{2}{3} \Leftrightarrow \frac{r_{cq}^{\,2} r_{bq} r_{tq} + r_{cq} r_{bq}^{\,2} r_{tq} + r_{cq} r_{bq} r_{tq}^{\,2}}{r_{cq}^{\,2} r_{bq}^{\,2} + r_{cq}^{\,2} r_{tq}^{\,2} + r_{cq}^{\,2} r_{tq}^{\,2}} \cong \frac{1}{4} \quad \textbf{(II-3a/b/c)}$$

*

## Part III. The prediction of a cyclic universe

**Hypothesis 7 (H7)**. If we consider that both quantum angular momentum and speed of the photon (in vacuum) are maximum constants in all the moments of evolution of our universe (so that $\hbar_{\max} \overset{hyp.}{=} \hbar_{\min} \overset{hyp.}{=} \hbar$ and $v_{\max} \overset{hyp.}{=} c$), the existence of $N_a$ may also imply a finite energy ambitus $\boxed{\frac{E_{\max}}{E_{\min}} = \frac{\hbar\omega_{\max}}{\hbar\omega_{\min}} = N_a}$, a finite mass ambitus $\boxed{\frac{m_{\max}}{m_{\min}} = \frac{E_{\max}/c^2}{E_{\min}/c^2} = N_a}$ and a finite angular momentum ambitus $\boxed{\frac{L_{\max}}{L_{\min}} = \frac{E_{\max}t_{\max}}{E_{\min}t_{\min}} = {N_a}^2}$ for all QCs in our universe.

**(1)** The total spacetime (**ST**) entropy $\left(S_{ST}\right)$ may be defined as directly-proportional to the average angular frequency $\omega_{ST}$ and the average linear speed $v_{ST}$ of all +/-BCs composing spacetime n-branes, so that: $\boxed{S_{ST} \propto \omega_{ST}} \Leftrightarrow \boxed{S_{ST} \propto v_{ST}}$, with $\omega_{ST} \in \left[\omega_{\min}, \omega_{\max}\right]$ and $v_{ST} \in \left[v_{\min}, v_{\max}\right]$.

**(2)** The total entropy of all QPs $\left(S_{QP}\right)$ may be defined as directly-proportional to the average angular frequency $\omega_{QP}$ and the average linear speed $v_{QPs}$ of all +/-BCs composing QPs n-branes, so that: $\boxed{S_{QP} \propto \omega_{QP}} \Leftrightarrow \boxed{S_{QP} \propto v_{QP}}$, with $\omega_{QP} \in \left[\omega_{\min}, \omega_{\max}\right]$ and $v_{QP} \in \left[v_{\min}, v_{\max}\right]$.

**(3)** In the context of the entropic gravity theory (aka emergent gravity) proposed and developed by Erik Verlinde [**5**], the universal gravitational constant can be redefined as a quantum G scalar function of $\hbar_{\max} \overset{hyp.}{=} \hbar_{\min} \overset{hyp.}{=} \hbar$, $v_{\max} \overset{hyp.}{=} c$ and the average $\omega_{ST}$ (the average angular frequency of all +/-BCs of spacetime 2-branes in this present moment of our universe evolution) such as: $\boxed{G_q\left(\omega_{ST}\right) \overset{redef.}{=} \frac{c^5/\hbar}{{\omega_{ST}}^2}}$. $G_q\left(\omega_{ST}\right)$ becomes an indirect measure of the spacetime entropy $S_{ST}$: the larger the $\omega_{ST}$ the larger the spacetime entropy $S_{ST}$ and the smaller the $G_q\left(\omega_{ST}\right)$; the smaller the $\omega_{ST}$ the smaller the spacetime entropy $S_{ST}$ and the larger the $G_q\left(\omega_{ST}\right)$.

a. At low length scales, the hypothetical spacetime 2-branes may appear as 3D locally so that the strength of the gravitational field (**GF**) measured by $G_q\left(\omega_{ST}\right)$ may vary (at these low length scales) inverse-proportionally with a 2D spherical front with area $4\pi r^2$.

b. At sufficiently large length scales, the hypothetical spacetime 2-branes may appear as 2D (flat) globally, so that the strength of the gravitational field (**GF**) measured by $G_q\left(\omega_{ST}\right)$ may vary (at these sufficiently large length scales) inverse-proportionally with a 1D circular front with circumference $2\pi r$: this prediction of H3 agrees to that of Verlinde's entropic gravity which implies a modified Newtonian dynamics (MOND).

**(6)** As $\omega_{ST} \in \left[\omega_{\min}, \omega_{\max}\right]$, then $G_q\left(\omega_{ST}\right) \in \left[\frac{c^5/\hbar}{\omega_{\max}{}^2}, \frac{c^5/\hbar}{\omega_{\min}{}^2}\right]$, so that there will also exist a pair $G_{q(\min)}\left(=\frac{c^5/\hbar}{\omega_{\max}{}^2}\right), G_{q(\max)}\left(=\frac{c^5/\hbar}{\omega_{\min}{}^2}\right)$ so that $\boxed{\frac{G_{q(\max)}}{G_{q(\min)}}\left(=\frac{L_{\max}}{L_{\min}}=\frac{l_{\max}}{l_{\min}}\right)=N_a{}^2}$;

**(7)** H7 also states that the variations of $\omega_{ST}$ and $\omega_{QP}$ are inverse and complementary so that when $\omega_{QP}$ increases, $\omega_{ST}$ decreases and vice versa: this implies that when $S_{QP}$ increases, $S_{ST}$ decreases and vice versa. The inflation of our universe is defined as $\left(\uparrow \omega_{QP}, \downarrow \omega_{ST}\right) \Leftrightarrow \left(\uparrow S_{QP}, \downarrow S_{ST}\right) \Leftrightarrow \uparrow G_q\left(\omega_{ST}\right)$. A hypothetical deflation of our universe is defined as $\left(\downarrow \omega_{QP}, \uparrow \omega_{ST}\right) \Leftrightarrow \left(\downarrow S_{QP}, \uparrow S_{ST}\right) \Leftrightarrow \downarrow G_q\left(\omega_{ST}\right)$.

**(8)** H7 predicts that $G_q\left(\omega_{ST}\right)$ may vary with the age of our universe $t_{\text{var}}$ following a simple function such as $\boxed{G_q\left(t_{\text{var}}\right) \overset{hyp.}{=} N_a{}^{2\frac{t_{\text{var}}}{t_{\max}}} \frac{c^5/\hbar}{\omega_{\max}{}^2}}$, with $t_{\text{var}} \in \left[t_{\min}, t_{\max}\right]$: $G_q\left(t_{\min}\right) \cong G_{q(\min)}$ and $G_q\left(t_{\max}\right) \cong G_{q(\max)}$.

**(9)** H7 additionally states that it is very plausible for $G_q\left(t_{\text{var}}\right)$ to reach values high enough (very close to $G_{q(\max)}$) so to decelerate and then stop the global inflation of our universe (global confinement); the same $G_{q(\max)}$ may then initiate a global deflation of our universe: this global deflation may be dominated by an inverted 2nd law of thermodynamics; in this view, $t_{\max}$ may signify the total duration of a global inflation/deflation half-cycle of our universe, so that an inflation-deflation full-cycle will have duration $t_c = 2t_{\max}$; towards the end of deflation, $G_q\left(t_{\text{var}}\right)$ may reach very small values (values very close to $G_{q(\min)}$) so that attractive gravity may be easily be dominated by the electromagnetic and strong nuclear repulsive forces (asymptotic freedom) and a new inflation may begin again; in this way, H7 essentially predicts a cyclic Big Bounce universe with no true gravitational singularities, but only quasi-singularities that initiate inflation and deflation half-cycles;

a. In this way, H7 doesn't need dark energy and matter to explain the cyclic behavior of this hypothetical universe;
b. furthermore, H7 predicts a non-explosive slowly initiated and non-singularity Big Bang and Big Crunch, with a potential infinite number of inflation-deflation full-cycles of our universe;
c. furthermore, H7 predicts that our universe will have a cyclic behavior independently of its mass and density, as $G_q\left(t_{\text{var}}\right)$ is defined and predicted as a propriety of the spacetime itself (independent of the total mass and density of all QPs of our universe);

**(10)** As our universe is relatively young (with a present age estimated as $t_u \cong 13.8 \times 10^9$ *years* and a GF with a strength that is with ~40 orders of magnitude smaller than the other three known fundamental fields), H7 predicts that $\omega_{Pl(present)}$ may be a good approximation of $\omega_{\max}$ so that $\boxed{\omega_{Pl(present)} \overset{hyp.}{\cong} \omega_{\max}} \Leftrightarrow \boxed{t_{Pl(present)} \overset{hyp.}{\cong} t_{\min}} \Leftrightarrow \boxed{G_{present} \overset{hyp.}{\cong} G_{q(\min)}}$;

**(11)** H7 also predicts that $\boxed{t_{\max} \overset{hyp.}{\gg} t_u \gg \left( t_{Pl} \overset{estim.}{\cong} t_{\min} \right)} \Rightarrow \boxed{\frac{t_{\max}}{t_{\min}} \left( = N_a \right) \gg \frac{t_u}{t_{Pl}}} \Rightarrow$

$\boxed{N_a \overset{hyp.}{\gg} 8.1 \times 10^{61}}$.

**(12)** H7 speculates that the fine structure constant (**FSC,** $\alpha$) at rest (as directly and precisely determined by using the quantum Hall effect of the electron) may remain constant on an inflation-deflation full-cycle of our universe and may be in fact an indirect measure of a plausible global scaling factor $N_a \overset{hyp}{\cong} 3.2 \times 10^{82} \left( \gg 8.1 \times 10^{61} \right)$, so that $(n_a \overset{def.}{=} \sqrt{N_a}) \overset{hyp}{\cong} 1.8 \times 10^{41}$, $\alpha \overset{hyp.}{=} 1/\log_2(n_a) \cong 1/137.036$ and $(a \overset{def.}{=} 1/\alpha) \overset{hyp.}{=} \log_2(n_a) \cong 137.036$. As $\frac{\hbar c}{k_e {q_e}^2} \overset{def.}{=} \left[ a = \log_2(n_a) \right]$, $\hbar_{\max} \overset{hyp.}{=} \hbar_{\min} \overset{hyp.}{=} \hbar$ and $v_{\max} \overset{hyp.}{=} c$ (on an inflation-deflation full cycle) $k_e {q_e}^2$ can be redefined as $k_e {q_e}^2 \overset{redef.}{=} \left[ \hbar c / a = \hbar c / \log_2(n_a) \right]$ and is also predicted to remain constant on an inflation-deflation full cycle of our universe.

a. $N_a$ is also close to the gravity-related ratios between the rest-mass $M_{ou} \cong 3.1 \times 10^{54} kg$ of our observable universe (**ou**) and the non-0 rest masses of the proton $(m_p)$ and electron $(m_e)$, such as: $M_{ou} / m_p \cong (1.8 \times 10^{81} = N_{Eddington})$, $M_{ou} / m_e \cong 3.4 \times 10^{84}$ and $\boxed{M_{ou} / \sqrt{m_p \cdot m_e} \cong 7.9 \times 10^{82}}$.

b. Additionally, the length $n_a \cdot r_{ec} \cong 5 \times 10^{26} m$ (with $r_{ec} = k_e {q_e}^2 / \left( m_e c^2 \right) \cong 2.8 \times 10^{-15} m$ being the classical electron radius), has a value which is relatively close to the gravity-related estimated radius of our ou $R_{ou} \cong 4.4 \times 10^{26} m$, so that $\boxed{n_a \cdot r_{ec} \overset{pred.}{\cong} 1.14 \cdot R_{ou}}$ and $\boxed{\log_2(R_{ou} / r_{ec}) \cong 136.85 \overset{99.86\%}{\cong} a}$. The same with the length $n_a \cdot r_p \cong 1.6 \times 10^{26} m$ (with $r_p \cong 0.87 \times 10^{-15} m$ being the radius of the proton as determined by scattering using electrons, not muons) which is also relatively close to $R_{ou}$ so that, $\boxed{n_a \cdot r_p \overset{pred.}{\cong} 0.35 \cdot R_{ou}}$ and $\boxed{\log_2(R_{ou} / r_p) \cong 138.54 \overset{101.12\%}{\cong} a}$.

c. Additionally, $c / (n_a \cdot r_p) \overset{pred.}{\cong} 59.5 \left[ (km/s)/Mpc \right] \overset{88\%}{\cong} H_0$, with $H_0 \cong 67.6 \left[ (km/s)/Mpc \right]$ being the Hubble constant as determined by the latest measurements from 2015.

d. Additionally, the constant $\boxed{\sqrt{a^3 n_a} \cong 6.78 \times 10^{23}}$ is very close to the numerical value of the Avogadro constant $N_A \cong 6.023 \times 10^{23} \left( number\ of\ molecules / mole \right)$, so that $\boxed{(a^{3/2} {N_a}^{1/4} = \sqrt{a^3 n_a}) \overset{112.58\%}{\cong} N_A}$.

**(13)** H7 also states that not only $N_a$, $n_a = \sqrt{N_a}$, $a = \log_2(n_a)$, $\hbar$, $c$ and $k_e q_e{}^2 = \hbar c / a$ may remain constant on an inflation-deflation full cycle of our universe, but also the rest mass of the electron/positron $m_e$ is also stated to remain constant on such a full cycle, as $m_e$ is determined by the strong gravity-like (**SGF-like**) unified primordial field (**UPF**) which is predicted by H7 to have a relative fixed strength on a full universal cycle.

**(14)** There is a striking closeness $\sqrt{2a^{3/2}n_a}\left(m_e c^2 / \hbar\right) \overset{100.2\%}{\cong} (\omega_{Pl} \overset{hyp.}{\cong} \omega_{\max})$ based on which H7 proposes a new candidate for the $\omega_{\max}$ (independent of the empirically determined G and $\omega_{Pl}$) as a function of $E_e = m_e c^2$, such as: $\boxed{\omega_{\max(e)} \overset{def.}{=} \sqrt{2a^{3/2}n_a}\left(E_e / \hbar\right)}$

$\cong 1.86 \times 10^{43} rad/s$ and $\boxed{E_{\max(e)} \overset{def.}{=} \left(\hbar\omega_{\max(e)} = E_e\sqrt{2a^{3/2}n_a}\right)} \cong 1.22 \times 10^{19} GeV$ (which is a good approximation of Planck energy $E_{Pl}$, which is the hypothetical energy scale of unification of all the four fundamental fields), $\boxed{E_{\min(e)} \overset{def.}{=} \left(E_{\max(e)} / N_a = E_e\sqrt{2a^{3/2} / n_a{}^3}\right)}$,

$\left(t_{\min(e)} \overset{def.}{=} 1/\omega_{\max(e)}\right) \overset{99.8\%}{\cong} t_{Pl}$.

a. $t_{\max(e)}$ can be estimated using $t_{\min(e)}$ and $N_a$, such as $\boxed{t_{\max(e)} = N_a \cdot t_{\min(e)}}$ $\overset{estim.}{\cong} 1.7 \times 10^{39} s \cong 5.44 \times 10^{31} years$, so that $t_{\max(e)}$ is in the lowest portion of the interval of the estimated mean lifetime of the proton $t_p \overset{\substack{exp.\\estim.}}{\in} \left[10^{31}, 10^{36}\right] years$, as predicted by some grand unified theories (**GUTs**) based on the possible existence of another force-carrier particle (boson) that may cause the proton decay (however, the Standard Model predicts a stable proton with a practically infinite lifetime): in other words, it is possible that a fraction of the protons of our universe to decay until the finish of the inflation half-cycle of our universe (**OU**), but with the possibility of being recomposed at the end of a deflation half-cycle of OU (by huge spatial compression of all energy and matter contained in OU in a deflation cycle dominated by a GF with very high strength).

**(15)** $G_q\left(t_{\text{var}}\right)$ can be redefined using $\omega_{\max(e)}$, such as: $\boxed{G_q\left(t_{\text{var}}\right) \overset{hyp.}{=} N_a{}^{\frac{2t_{\text{var}}}{t_{\max(e)}}} \frac{c^5 / \hbar}{\omega_{\max(e)}{}^2}} \Leftrightarrow$

$\boxed{G_q\left(t_{\text{var}}\right) \overset{hyp.}{=} N_a{}^{\frac{2t_{\text{var}}}{t_{\max(e)}}} \frac{\hbar c^5}{E_{\max(e)}{}^2}} \Leftrightarrow \boxed{G_q\left(t_{\text{var}}\right) \overset{hyp.}{=} \frac{N_a{}^{\frac{2t_{\text{var}}}{t_{\max(e)}}}}{2a^{3/2} / n_a{}^3} \cdot \frac{\hbar c^5}{E_e{}^2}}$, with

$G_{q(\min)} = G_q\left(t_{\min(e)}\right) \cong 6.648 \times 10^{-11} m^3 kg^{-1} s^{-2}$ and

$G_{q(\max)} = G_q\left(t_{\max(e)}\right) \cong 3.22 \times 10^{154} m^3 kg^{-1} s^{-2} \cong 4.83 \times 10^{164} G$.

a. $G_q\left(t_u\right) \cong G_{q(\min)} \cong 6.648 \times 10^{-11} m^3 kg^{-1} s^{-2}$ offers a good approximation of the experimental G value established by CODATA 2016: $G \cong 6.674 \times 10^{-11} m^3 kg^{-1} s^{-2}$.

b. Based on $G_q(t_{\text{var}})$, one can also define a variable gravitational coupling constant $\alpha_{Gq}(t_{\text{var}})$ associated with a pair of electrons/positrons, such as

$$\boxed{\alpha_{Gq}(t_{\text{var}}) \overset{hyp.}{=} \frac{G_q(t_{\text{var}})\cdot m_e^{\,2}}{\hbar c}} \Leftrightarrow \boxed{\alpha_{Gq}(t_{\text{var}}) \overset{hyp.}{=} N_a^{\frac{2t_{\text{var}}}{t_{\max(e)}}} E_e^{\,2} / E_{\max(e)}^{\,2}} \Leftrightarrow$$

$$\boxed{\alpha_{Gq}(t_{\text{var}}) \overset{hyp.}{=} \frac{N_a^{\frac{2t_{\text{var}}}{t_{\max(e)}}}}{2a^{3/2}n_a}}, \text{ with } \alpha_{Gq(\min)} = \alpha_{Gq}\left(t_{\min(e)}\right) \cong 1.74\times10^{-45} \text{ and}$$

$\alpha_{Gq(\max)} = \alpha_{Gq}\left(t_{\max(e)}\right) \cong 1.78\times10^{120}$. $\alpha_{Gq}(t_u) \cong \alpha_{Gq(\min)} \cong 1.74\times10^{-45}$ offers a good approximation of the gravitational coupling constant for a pair of electrons/positrons $\alpha_G = \frac{Gm_e^{\,2}}{\hbar c} \cong 1.75\times10^{-45}$.

c. The function $\boxed{p(t_{\text{var}}) = \log_{10}\left[\alpha_{Gq}(t_{\text{var}})\right]}$ has two phases:

i. a first phase with a very slow growth rate in the interval $\left[t_{\min(e)}, 10^{30}\, years\right]$ from ~(-44) to (-41) which corresponds to a growth from $\alpha_{Gq}\left(t_{\min(e)}\right) \cong 1.74\times10^{-45}$ to $\alpha_{Gq}\left(10^{30}\, yr\right) \cong 1.86\times10^{-42}$;

ii. a second phase with an "explosive" growth in the interval $\left[10^{30}\, years, t_{\max(e)}\right]$ from -44 to ~120, which corresponds to a growth from $\alpha_{Gq}\left(10^{30}\, yr\right) \cong 1.86\times10^{-42}$ to $\alpha_{Gq}\left(t_{\max(e)}\right) \cong 1.78\times10^{120}$, a very marked growth that may produce a global confinement of our universe and the start of its hypothetical deflation half-cycle. $p(t_{\text{var}})$ is the hallmark of a huge but finite spacetime global "elasticity", with $\alpha_{Gq}(t_{\text{var}})$ measuring the stretching potential of spacetime at a specific moment of its evolution. **See the next graph**.

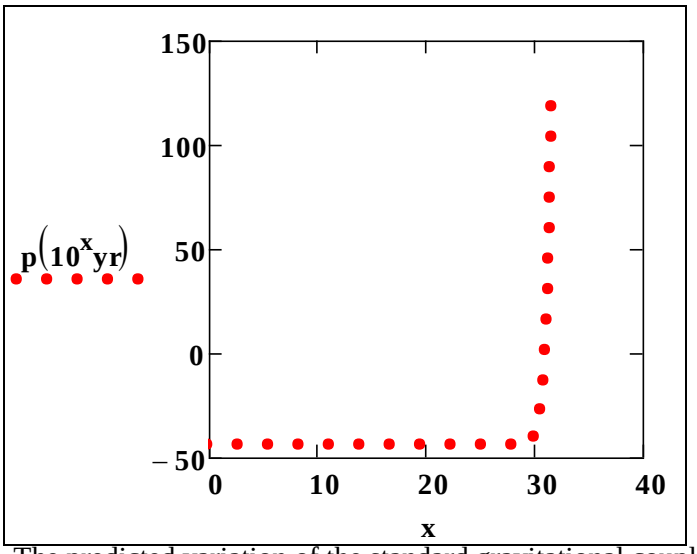


**Figure III-1.** The predicted variation of the standard gravitational coupling constant with the aging of our universe in base-10 logarithmic scale measured by function $p(t_{var})$

**(4)** H7 also proposes that our universe may have a very large total rest energy $E_U$, mass $M_U$ and radius $R_U$ (definitely much larger than the rest energy, mass and size of the observable universe), but doesn't/cannot have an infinite rest energy, mass, nor it can attain an infinite radius by global inflation, so that $M_{\max}\left(\gg M_U\right)\notin\{0, 1/\infty, \infty\}(kg)$, $E_{\max}\left(=M_{\max}\cdot {v_{\max}}^2\right)\left(\gg E_U\right)\notin\{0, 1/\infty, \infty\}(J)$ and $R_{\max}\left(\gg R_U\right)\notin\{0, 1/\infty, \infty\}(m)$: this also implies the existence of a finite maximum (non-0 and non-infinitesimal, constant or variable) total (average) linear momentum of our universe: $p_{\max}\left(=M_{\max}\cdot v_{\max}\right)\notin\{0, 1/\infty, \infty\}(kg\cdot m/s)$, with $p_{\max}\gg p_U$.

a. Given its capacity to produce an infinite number of virtual and real particle-antiparticle pairs (based on +/-BCs), our universe is potentially infinite, but is conjectured to be actually finite, so that it only contains a finite quantity of real particle-antiparticle pairs.

*

## Part IV. The unification of all fundamental fields into the unified primordial field (UPF)

**Hypothesis 8 (H8)**. H8 proposes that gravity (as measured by the gravitational coupling constant previously defined) may also vary with the length scale and energy scale (implicitly) in the same double closed interval $\left[\alpha_{Gq(\min)}, \alpha_{Gq(\max)}\right]$ such as (**see also the next figure**):

$$\alpha_{Gq}\left(E_{\text{var}}\right)\overset{hyp.}{=}\frac{N_a^{\frac{2E_{\text{var}}}{E_{\max(e)}}}}{2a^{3/2}n_a} \quad \textbf{(IV-1)}$$

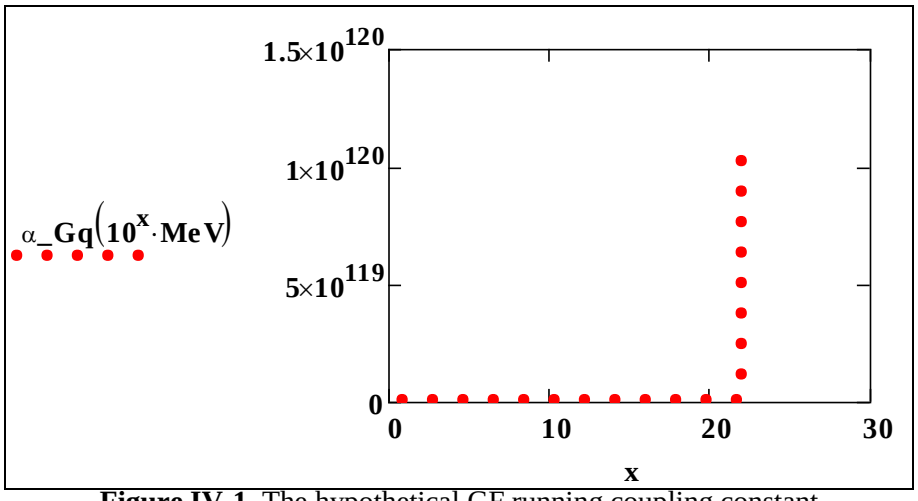


**Figure IV-1**. The hypothetical GF running coupling constant based on the scaling factor $n_a=\sqrt{N_a}$ and $x\in\left[\log_{10}\left(\frac{E_{\min(e)}}{1MeV}\right), \log_{10}\left(\frac{E_{\max(e)}}{1MeV}\right)\cong 22.087\right]$

**(1)** The running coupling constant of the electromagnetic field (**EMF**) determined in quantum electrodynamics (**QED**) using the beta function can be written as

$$\alpha f_0\left(E_{\text{var}}\right) \overset{\text{exp.}}{\cong} \frac{\alpha}{1-\frac{\alpha}{3\pi}\ln\left[\left(E_{\text{var}}/E_e\right)^2\right]}$$ for $E_{\text{var}} \gg \left(E_e = m_e c^2 \cong 0.51 MeV\right)$ (the rest energy of the electron/positron) **[6,7]**.

a. $\alpha f_0\left(E_{\text{var}}\right)$ can be also approximated using the same scaling factor $n_a \overset{def.}{=} \sqrt{N_a}$, such as $$\alpha f\left(E_{\text{var}}\right) \overset{hyp.}{=} \frac{1}{\log_2\left[n_a\left(\frac{E_e}{E_{\text{var}}}\right)^{\frac{\ln(4)}{3\pi}}\right]}.$$

b. Based on the definition $$E_{\max(e)} \overset{def.}{=} \left(\hbar\omega_{\max(e)} = E_e\sqrt{2a^{3/2}n_a}\right) \Leftrightarrow E_e \overset{99.8\%}{\cong} E_{\max(e)}/\sqrt{2a^{3/2}n_a}$$, $\alpha f\left(E_{\text{var}}\right)$ can be rewritten (based on this relatively precise approximation) such as (**see also the next figure**):

$$\alpha f\left(E_{\text{var}}\right) \overset{hyp.}{=} \frac{1}{\log_2\left[n_a\left(\frac{E_{\max(e)}}{E_{\text{var}}\sqrt{2a^{3/2}n_a}}\right)^{\frac{\ln(4)}{3\pi}}\right]} \quad \textbf{(IV-2)}$$

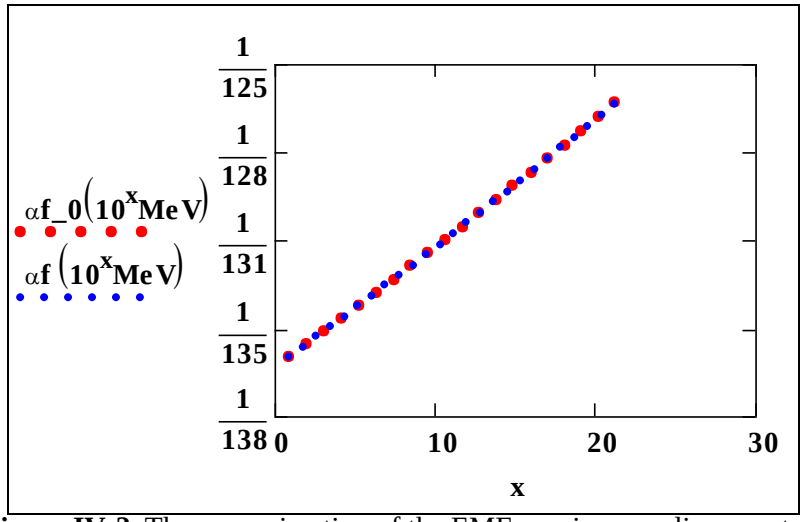


**Figure IV-2**. The approximation of the EMF running coupling constant based on the scaling factor $n_a = \sqrt{N_a}$

c. As it can be seen, this rewritten $\alpha f\left(E_{\text{var}}\right)$ doesn't generate infinities in the interval $\left[E_{\min(e)}, E_{\max(e)}\right]$, so it solves (at least partially) the triviality issue of QED for the finite maximum energy ambitus $\left[E_{\min(e)}, E_{\max(e)}\right]$. $\alpha f\left(E_{\text{var}}\right)$ generates a Landau

pole only for $\boxed{E_{\text{var}} = \left( E_{sup} \overset{def.}{=} E_e \cdot {n_a}^{3\pi/\ln(4)} \right)}$, with $\boxed{E_{sup} \cong 1.45 \times 10^{277} GeV \cong 1.45 \times 10^{280} MeV}$ which is much more larger than the energy values from the interval $\left[ E_{\min(e)}, E_{\max(e)} \right]$. $E_{sup}$ is about 196 orders of magnitude larger than the rest energy of the observable universe $E_{ou} \overset{\text{exp.}}{\cong} 2 \times 10^{81} GeV$ and may be an upper bound for the total (rest plus kinetic) energy of our universe, which was conjectured to have a very large but finite total rest energy (also implying a finite total kinetic energy $E_{U(kinetic)} = \frac{E_{U(rest)}}{c^2} \cdot {v_{\max}}^2 = M_{U(rest)} \cdot {v_{\max}}^2$ if the maximum speed allowed in our universe $v_{\max}$ is also set as finite to $c \overset{hyp.}{=} v_{\max}$). Imposing $E_{sup}$ as an upper limit for the total (rest plus kinetic) energy of our universe (which is stated to be strictly lower than $E_{sup}$) may completely solve the triviality issue of QED, as applying $\alpha f\left(E_{\text{var}}\right)$ on $E_{sup}$ wouldn't have any physical meaning, so that $\alpha f\left(E_{\text{var}}\right)$ may only be applied on energy scales strictly smaller than $E_{sup}$.

**(2)** The running coupling constant of the strong nuclear field (**SNF**) determined in quantum chromodynamics (**QCD**) (also) using the beta function can be written as

$$\boxed{\alpha f_{S0}\left(E_{\text{var}}\right) \overset{\text{exp.}}{\cong} \begin{cases} = \dfrac{-2\pi}{\beta_0 \cdot \ln\left(E_{\text{var}} / E_{SNF}\right)}, with \begin{cases} \beta_0 \overset{def.}{=} -11 + 2n/3 = -7 \\ E_{SNF} \underset{def.}{\overset{\text{exp.}}{\cong}} 210\left(\pm 40\right) MeV \end{cases} \\ = \dfrac{2\pi}{7\ln\left(E_{\text{var}} / E_{SNF}\right)}, valid\ for\ E_{\text{var}} \gg E_{SNF} \end{cases}} \quad [\mathbf{8}].$$

a. $\alpha f_{S0}\left(E_{\text{var}}\right)$ can also be "translated" as $\boxed{\alpha f_{S0}\left(E_{\text{var}}\right) \cong \frac{1}{\log_2\left[\left(\frac{E_{\text{var}}}{E_{SNF}}\right)^{\frac{7\ln(2)}{2\pi}}\right]} = \frac{1}{\frac{7\ln(2)}{2\pi}\log_2\left(\frac{E_{\text{var}}}{E_{SNF}}\right)}}$.

b. Based on the relative closeness $\left[\frac{E_{SNF}}{E_{\max(e)} / N_a} \cong 5.4774 \times 10^{62}\right] \overset{109.9\%}{\cong} \left[{n_a}^{3/2} \cdot \sqrt{a/\pi} \cong 4.98 \times 10^{62}\right] \Leftrightarrow \boxed{E_{SNF} \overset{109.9\%}{\cong} E_{\max(e)} \sqrt{\frac{a/\pi}{n_a}}}$, $\alpha f_{S0}\left(E_{\text{var}}\right)$ can be rewritten (by a reasonable approximation) such as (**see also the next figure**):

$$\alpha f_S\left(E_{\text{var}}\right)=\frac{1}{\log_2\left[\left(\frac{E_{\text{var}}\cdot {n_a}^{1/2}/\sqrt{a/\pi}}{E_{\max(e)}}\right)^{\frac{7\ln(2)}{2\pi}}\right]}=\frac{1}{\frac{7\ln(2)}{2\pi}\log_2\left(\frac{E_{\text{var}}\cdot {n_a}^{1/2}/\sqrt{a/\pi}}{E_{\max(e)}}\right)} \quad \textbf{(IV-3)}$$

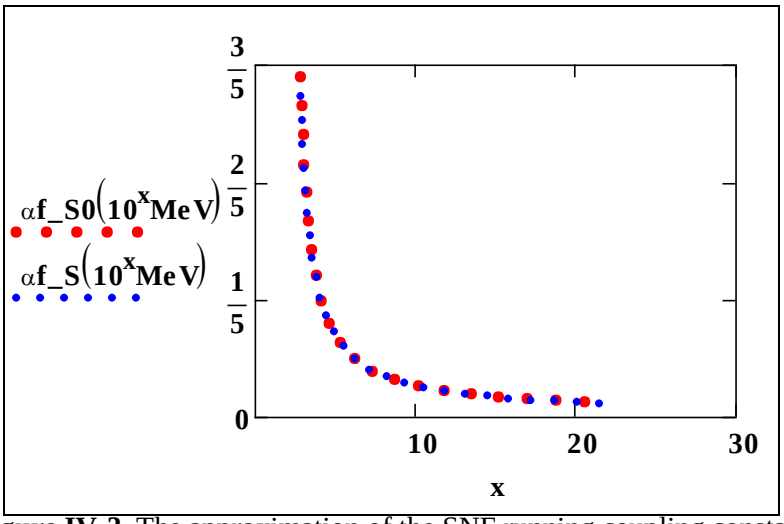


**Figure IV-3**. The approximation of the SNF running coupling constant based on the scaling factor $n_a=\sqrt{N_a}$

**(3)** The running coupling constant of the weak nuclear field (**WNF**) $\alpha f_{W0}\left(E_{\text{var}}\right)$ includes the rest energies of the W/Z bosons (which are the propagators of the WNF) and is also based on the Fermi coupling constant $G_F/(\hbar c)^3 \overset{\text{exp.}}{\cong} 1.1663787\times10^{-5}GeV^{-2}$ (with $G_F\cong1.43585\times10^{-62}Jm^3$), which can be indirectly determined by measuring the muon lifetime experimentally. $\alpha f_{W0}\left(E_{\text{var}}\right)$ can be written as $\boxed{\alpha f_{W0}\left(E_{\text{var}}\right)\overset{\text{exp.}}{\cong}\frac{{E_{WZ}}^2 G_F/(\hbar c)^3}{e^{E_{WZ}/E_{\text{var}}}}}$, with $E_{\text{var}}\in\left[E_{\min(e)},E_{\max(e)}\right]$, the average rest mass of W/Z bosons $m_{WZ}$ defined formally as $m_{WZ}=\sqrt{m_W\cdot m_Z}$ and the average rest energy of W/Z bosons $\boxed{E_{WZ}=m_{WZ}c^2}$ [**9**,**10**,**11**,**12**].

a. Based on the relative closeness $\left[\frac{E_{WZ}}{E_{\max(e)}/N_a}\cong2.231\times10^{65}\right]\overset{92.1\%}{\cong}\left[2\left(a\cdot n_a\right)^{3/2}\cong2.422\times10^{65}\right]\Leftrightarrow\boxed{E_{WZ}\overset{92.1\%}{\cong}E_{\max(e)}2a^{3/2}/\sqrt{n_a}}$, $\alpha f_{W0}\left(E_{\text{var}}\right)$ can be rewritten such as:

$$\boxed{\alpha f_W\left(E_{\text{var}}\right)\overset{hyp.}{=}\frac{{E_{WZ}}^2 G_F/(\hbar c)^3}{e^{\frac{2a^{3/2}\cdot E_{\max(e)}}{E_{\text{var}}\sqrt{n_a}}}}} \quad \textbf{(IV-4)}$$

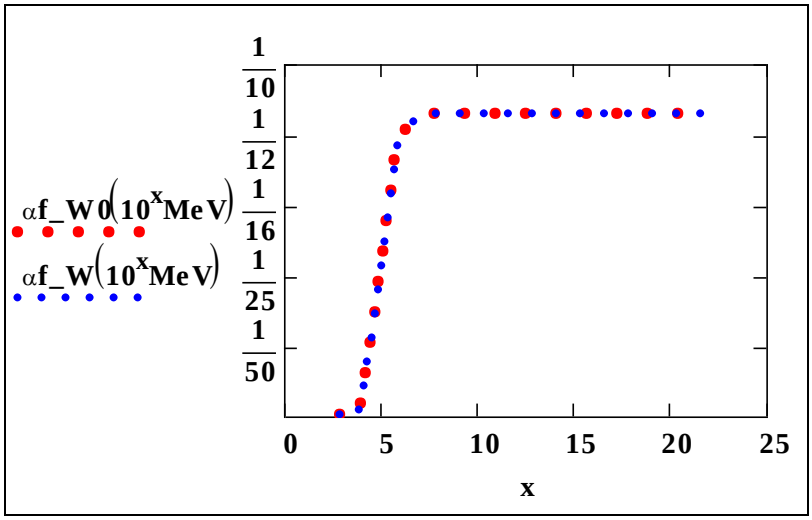


**Figure IV-4**. The approximation of the SNF running coupling constant based on the scaling factor $n_a = \sqrt{N_a}$

**(4)** The approximated running coupling constants of GF, EMF, SNF and WNF can all be represented on the same graph using the base-10 logarithmic functions $p_{GF}(E_{\text{var}}) = \log_{10}\left[\alpha_{Gq}(E_{\text{var}})\right]$, $p_{EMF}(E_{\text{var}}) = \log_{10}\left[\alpha f(E_{\text{var}})\right]$, $p_{SNF}(E_{\text{var}}) = \log_{10}\left[\alpha f_S(E_{\text{var}})\right]$ and $p_{WNF}(E_{\text{var}}) = \log_{10}\left[\alpha f_W(E_{\text{var}})\right]$: **see the next figure.**

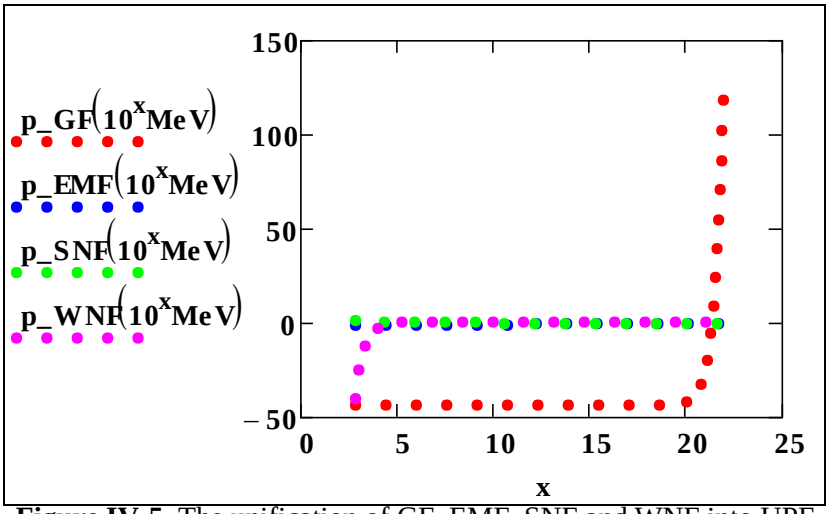


**Figure IV-5**. The unification of GF, EMF, SNF and WNF into UPF using approximating functions based on the same scaling factor $n_a = \sqrt{N_a}$

a. From the last figure, GF appears as a residual UPF probably generated by a very small percent of P bosons (predicted as being actually gravitons) that manage to escape the quark/leptonic 2D spherical surfaces.
b. There is an interesting mirror-like symmetry between $p_{GF}(E_{\text{var}})$ and $p_{WNF}(E_{\text{var}})$ in the intervals $[2.5, 22] \supset x$ and $[-46, 0] \supset \left\{p_{GF}(E_{\text{var}}), p_{WNF}(E_{\text{var}})\right\}$
c. H8 and H6 together predict that the phenomenon of P-bosons escape from the quark/leptonic surfaces will progressively loosen the strength of UPF manifested on those surfaces, so that the quark/leptonic non-0 radii will progressively increase with the

aging of our universe (considering the quark/lepton rest masses $m_x$ fixed on a full cycle of our universe), such as:

$$r_{L(gen)}(m_x,t_{\text{var}}) \overset{hyp.}{=} \left(\frac{\alpha\hbar^3 G_q(t_{\text{var}})}{m_x{}^2 c^5}\right)^{1/4} = \left(\frac{\alpha\hbar^4}{m_x{}^2 E_{\max(e)}{}^2}\right)^{1/4} N_a^{\frac{t_{\text{var}}}{2t_{\max(e)}}} \quad \textbf{(IV-5)}$$

i. The variation of the ratio $p_L(t_{\text{var}}) = \log_{10}\left[r_{L(gen)}(m_x,t_{\text{var}})/l_{\min(e)}\right]$ predicts $r_{L(gen)}(m_e,t_u) \cong 7.3\times10^{-25} m$ and indicates that at the end of an inflation half-cycle quarks and leptons can reach radii around $r_{L(gen)}\left(m_e,t_{\max(e)}\right) \cong 1.3\times10^{17} m$ (**see the next figure**)

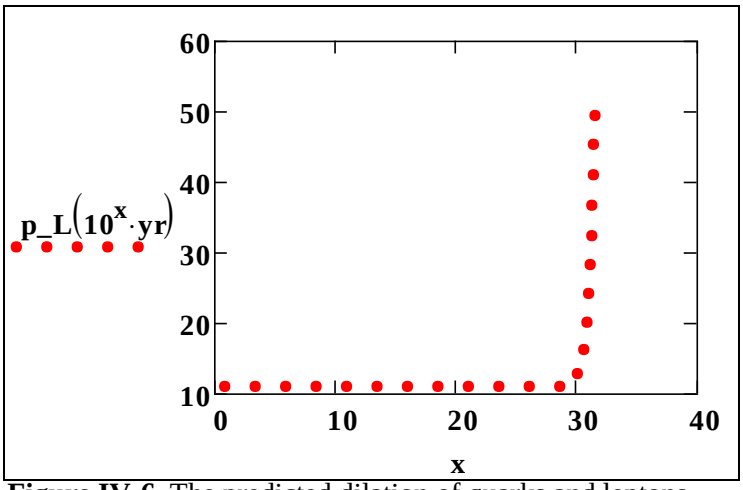


**Figure IV-6**. The predicted dilation of quarks and leptons with the aging of our universe

d. The strength of the GF (residual UPF) manifesting in the 3D space (external to the quark/lepton surfaces) will progressively grow with the increasing total number of gravitons (P-bosons) escaped in that 3D space: this phenomenon is measured by the variable $G_q(t_{\text{var}}) \overset{hyp.}{=} N_a^{\frac{2t_{\text{var}}}{t_{\max(e)}}} \hbar c^5 / E_{\max(e)}{}^2$

**(5)** $E_{\min(e)} = E_{\max(e)} / N_a \cong 3.83\times10^{-55} eV$ is a potential candidate for the rest mass of the P-boson (predicted as being the hypothetical graviton).

**(6)** H8 also states that our universe is a 4D universe and may have a finite total rest energy $E_{OU} = E_{\min(e)} \cdot N_a{}^4 \cong 10^{276} eV$ which is "safely" under the energy scale $E_{\text{sup}} \cong 10^{286} eV$ (above which QED generates trivialities).

**(7)** H8 also states that the second law of thermodynamics (**2LT**) may be the consequence of the present (relative) weakness of GF/residual UPF (when compared to the other three known fundamental fields): in this way, H8 predicts that the hypothetical deflation half-cycle of our universe shall/may be dominated by an inverted 2LT, which may explain the future spatial contraction of our universe, with a full-cycle duration of $t_c = 2t_{\max(e)} \cong 1.1\times10^{32}$ *years*.

**(8)** H8 predicts that our universe doesn't allow true gravitational singularities, but only quasi-Big-Bangs/Big-Crunches/Big-Freezes which permit smooth transitions (with no true "explosions") between two consecutive inflation half-cycle and deflation half-cycle and vice versa.

## Part V. Life phenomenon in a cyclic universe

**Hypothesis 9 (H9)**. The facts that life on Earth was demonstrated to be at least $\boxed{t_l \cong 4\times10^9\ years}$ old and that our observable universe (**ou**) has an estimated age $\boxed{t_{ou} \cong 13.8\times10^9\ years}$, indicate that the first life forms (**LFs**) may had been appeared after the passing of just about $\boxed{\left(t_{ou}-t_l\right)/t_c \cong 10^{-22}}$ of the whole universal cycle measured by $\boxed{t_c \cong 1.1\times10^{32}\ years}$ (starting from the quasi-Big-Bang moment): H9 considers very plausible that this fact may not be not just a simple coincidence, as there is a strong contrast between this very small fraction $\left(10^{-22}\right)$ and the astonishing complexity of LFs and life societies (the complexity of the Earth biosphere as a whole, with a lifespan of about $t_l / t_{ou} \cong 30\%$, which is a significant part of the $t_{ou}$ interval, which implies a significant overlap between $t_l$ and $t_{ou}$). Based on this double-argument, H9 also considers very plausible that life may be essentially a predesigned phenomenon probably "engraved" in the laws of nature (including the still unknown laws of our universe), and just secondarily shaped by different so-called "natural accidents". There are also some strong arguments that creationism and evolutionism can be unified in a more profound monad, as also described by the Fine-tuned universe theories, including the Anthropic (Cosmological) Principle. [**13**].

**(1)** It is generally considered that the non-0 probability of life existence strongly depends on: boson-fermion dichotomy (**BFD**) (associated with Pauli's exclusion principle [**PEP**] which apply to all fermions), some narrow intervals of allowed variations (±4%) for the fine structure constant (**FSC**) $\alpha$ values (at rest) and for the beta constants values at rest ($\beta_p = m_p / m_e$ and $\beta_n = m_n / m_e$) (which influence the formation and the life cycles of the stars, which are the main sources of energy for LFs and the only source of atoms heavier that the iron, which are vital microelements for LFs); it is also generally admitted (and partially proved by some experiments) that $\alpha$, $\beta_p$, $\beta_n$ values (at rest) have probably been "decided" (by so-called natural (pre)selection) in the first moments after the (hypothetical but very probable) (quasi-)Big-Bang. It was also demonstrated that the stability of all chemical structures that compose any LF mainly depend on BFD-PEP association, $\alpha$, $\beta_p$ and $\beta_n$ values (at rest). In order for the first LFs to appear by the 3rd step of "biological natural selection", proper chemical structures (atoms and molecules) must have been produced long before these first LFs by a 2nd step of "chemical natural (pre)selection": but this 2nd step of "chemical natural (pre)selection" strongly depends on $\alpha$, $\beta_p$ and $\beta_n$ values (at rest) that were also "naturally (pre)selected" at a relative short moment after the (quasi-)Big-Bang and this "selection" may be consider the 1st step of the "natural selection" process, that can be named the "alpha-beta natural (pre)selection". In this way, H9 proposes a "natural selection" in three "abc" steps:

a. the selection of the main physical principles and adimensional constants compatible with life (very close to the Big-Bang moment);
b. the selection of the atoms and molecules compatible with life;
c. the appearance of the first LFs that evolved by a so-called "natural selection" process.

**(2)** With these previously listed arguments, H9 proposes the unification of evolutionism and creationism in a monad (a seed-like model of the pre-Big-Bang quasi-singularity in which this quasi-singularity unpacks and repacks itself periodically, generating a universe populated with LFs), as it pushes the three abc-steps of "natural selection" very close to the moment "0" of the Big-Bang when $\alpha$, $\beta_p$, $\beta_n$ values (at rest) were probably "naturally" (but not necessarily randomly!) selected.

**(3) An important remark on the importance of FSC value in the structures and functions of LFs.** A change in the energy level of an electron in a molecule of a LF may produce a change in configuration of that molecule, a change that may also generate and transmit potential vital information for that LF. FSC can be interpreted as the probability of a real electron to emit a real photon (Feynman's interpretation): in biology, FSC can be "translated" as the main probabilistic measure of the relative stability of a molecular electronic cloud configuration that a LF can rely on as a generator and transmitter of information.

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