From Particle Physics to Cosmology, on the Gravitational Sub-structure of Everything

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We show, through resonance formulas, that the free parameters of the standard models of particle physics and cosmology fit a single resonant system – from the mass of elementary particles to gravitation and cosmology, and couplings mirroring resonances; and finally that all is encoded in the Planck mass resonance. Instead of extending the theory or its degrees of freedom to obtain predictions, we consider the reverse problem; paying interest to the free parameters structure we find formulas which consistency implies physical constraints hitherto unknown.

1 Introduction

Here we take a hypothesis that extends and generalizes Louis de Broglie's original idea of a wave and its resonance:

A single resonant phenomenon defines the physical world in its entirety where pulsations, wave numbers, and rotations refer to the same quantum and compare as lengths.

It leads to the direct calculation of the Sommerfeld constant with all the precision available [5]. This calculation implies a composite wave, so that the electron has a wave substructure, governed by mechanisms, of which electrodynamics is one effect – and then the same must be said of all particles. It is an intermediate result of a wider exploration published in part [5,6,8] which initially ranges from the mass of the electron to that of the Planck particle, via the associated couplings. This text presents more advanced results through a sequence of formulas consistent with each other and available data, with minimal concepts, and now extends to cosmology (following [7] in particular).

From the beginning of physics, the first aim is not to build a theory, but to explore virgin territory, analyze data and discover its internal logic and structure; mathematical theories always come after. Hence we present the results of an exploration of free parameters; first those obtained at the level of masses, second the associated couplings, third an approach to the origin, fourth the resulting natural cosmology, and last a few logical extensions. The method is straightforward: Find a general structure to a data set, insist on precision, understand the minimum and move on to the next set based on what is understood. Most importantly, precision will allow understanding some unexpected links between different data sets. Again, the aim is not to build a theory, but to poke holes in a supposed invisible wall of ignorance, a few bricks of which can be seen in the above-mentioned calculation.

This exploration is easily justified by the fact that theories beyond the Standard Model (SM) have nothing new to model and are therefore motivated by some kind of faith that something is missing. The various interpretations of quantum mechanics strongly suggest that something is missing at the bottom, and there is definitely a problem with our understanding of the nature of reality, a psycho-philosophical issue; so we shall discuss some formulas about its structure.

2 The mass spectrum

The Standard Model divides massive particles into four distinct groups of interaction symmetries. These symmetries necessarily reflect the internal mechanisms we assume. We must therefore rely on these groups to analyze masses and extract invariant quantities and universal mechanisms. The exception is the three massive bosons whose masses come from the same potential. The analysis is therefore reduced to three groups, with the three bosons forming one.

Particles are studied as resonances, which can be modeled as a cyclic phenomena. Suppose that the electron matter wave is made up of two waves crossing each other in a resonator of unit size. In one dimension, the harmonic N in a length 1 gives a frequency N^2 at which the anti-nodes of the two waves cross; N^2 is a wave number and $1/N^2$ a length. Then we add a coupling also modeled as a length, we get $K\,D$, with D the coupling-length and K an integer used to quantize. Now in one dimension we have a mass formula

$$m = \frac{1}{\left(\dfrac{1}{N^2} + K\,D\right)}\,, \tag{1}$$

which is roughly equivalent to the inverse relation between a mass and its Compton wavelength, and can be extended to more components; we may have composite resonances or couplings. In essence it addresses a harmonic system deformed by quantized couplings where mass is a harmonic mean – but this is only the 1-dimension case. In three dimensions, the resonance can be radial like in (1), circular or mixed, and are identified with three groups of particles. The radial case will correspond to the three electrons, bosons to the circular case, and the mixed case to quarks.

2.1 Electrons

The first mass formula applies to electrons and quarks:

$$m = \frac{X}{\left(\frac{1}{N\,P} + K\,D\right)^3} + \mu\,, \tag{2}$$

where

- X is a mass constant, the choice of a unit.
- (1) is raised to the cube since the wave occupies a three-dimensional volume. This formula is now thermodynamics' $P\,V = K_B\,T$, with a constant volume V where the oscillator defines $P \equiv T$.
- $N\,P$ are two integers for two waves components; either face to face (so $N = P$), or mixed with P radial and N circular (so $N \neq P$ and $2\,N\,P\,\pi \approx$ integer).
- And μ in units of mass represents a bridge between two complementary cuts of the resonance responding to each other, which is necessary to fit the electron masses, and justified by $U(1)_Y \times SU(2)_L \to U(1)_{EM}$.

So this formula must admit two solutions for each of the three electrons, with two sets of constants and resonances. The first one corresponds to a radial resonance and therefore $N = P$, which we call the primary field since the same constants will be used for all other particles. But the magnetic moment suggests a rotation, and in 3 dimensions a rotation implies an axis and one set of parallel planes is conserved; then $P = K$ imposes two synchronous axis combining the resonance and the effect of the rotation in the product $N\,P$, rotation to which N is orthogonal. We call this cut the secondary field.

An adjustment of the parameters to find the known masses with $N = P$ and a choice of minimal harmonics N, P, K lead to the primary field constants below (index e) and the harmonics and masses calculated in Table 1.

$$X_e = 8.14512139242128\,\mathrm{KeV/c^2}\,. \tag{3}$$

$$\mu_e = 0.24167661872330\,\mathrm{KeV/c^2}\,. \tag{4}$$

$$D_e = 8.53221893719202 \times 10^{-4}\,. \tag{5}$$

Table 1: Primary resonances; electron, muon, tau (KeV/c^2).

-	P=N	K	Calculated	Reference
e	2	2	510.99895000	510.99895000 (15)
μ	7 − 2	3	105,658.3760	105,658.3755 (23)
τ	7 + 2	5	1 776,840	1 776,861 (118)

For the secondary field we start with $N = P = K = 2$ for the electron as the three phases are synchronous in Table 1; imposing $P = K$ for the other two particles gives the constants below (index α) and Table 2, where the calculated masses are identical to those in Table 1 only for the decimals shown,

$$X_\alpha = 8.021608017449\,\mathrm{KeV/c^2}\,, \tag{6}$$

$$D_\alpha = 2.255984540570 \times 10^{-4}\,, \tag{7}$$

and μ_α in (8) linked to μ_e (4) by an empirical relation of obvious interest as we find three length ratios between rotations (giving π in the numerators) and twice the main term of the Sommerfeld constant calculation (137 in the denominators):

$$\frac{\mu_\alpha}{\mu_e} = \frac{\pi}{2} + \frac{\pi}{137} + \left(\frac{2\,\pi}{137}\right)^2 \tag{8}$$

$$\to \mu_\alpha = 0.3856750508181\,\mathrm{KeV/c^2}\,. \tag{9}$$

Table 2: Secondary resonances; electrons, muon, tau (KeV/c^2).

-	P=K	N	Calculated	Reference
e	2	2^1	510.99895000	510.99895000 (15)
μ	3	2^3	105,658.3760	105,658.3755 (23)
τ	4	2^4	1 776,840	1 776,861 (118)

Note 1) that the harmonics $P = K$ are minimal, and the powers of 2 for N; 2) that $K\,D > 0$ in Tables 1 and 2 is reminiscent of the Poincaré stress; and 3) that in the reduction $N = P = 7 \pm 2$ Table 1, which can be seen artificial in this table, 7 will be recurring for the other particles.

2.2 Quarks

For quarks, the formula (2) is used with $N \neq P$ for a mixed resonance where P is radial and N circular, and $\mu = 0$. The parameter X_e is that of the primary field (3), the coupling is composite, and combines D_e and Sommerfeld's constant α:

$$D_q = D_e\,(1 + \alpha)\,. \tag{10}$$

Table 3 shows the harmonics and calculated masses where the reference masses are in the natural scheme taken from Wikipedia (not found elsewhere in this scheme), and for the top quark a direct measurement average (PDG 2023).

Table 3: Quark resonances (MeV/c^2).

-	P	N	K	Calculated	Reference
u	3	14/7	−8	2.00	2.01 ± 0.14
d	3	19/7	−4	4.79	4.79 ± 0.16
s	3	7	−6	106	105 ± 25
c	3	14	−6	1,255	1250 ± 100
b	3	19	−6	4,286	4350 ± 150
t	3	38	−6	172,380	172, 690 ± 300

Several points in this table are remarkable:

- $P = 3$ is constant and appears consistent with fractional charges since $N = P = 2$ for the electron, and 2 ± 7 for the muon and tauon; meaning that 2 comes from the electric charge and 7 from something else.
- $K = -6$ for the four heavy quarks, the sum of the Ks is -12 for any generation.
- All N depend on 2, 7, and 19.
- In all three generations, there is a factor 2 in one resonance (N, or K), fitting the ratio of electric charge; consistent with α part of the coupling.
- The resonances of the u and d can actually be seen as a double mixture of the four others since $14/7 = 38/19$ and $19/7 = 38/14$.
- A mixed resonance imposes $2\pi N P \approx$ integer, which is well verified for all.

The coupling is composite and the parameter K is negative, indicating a second attractive force reminiscent of the strong force, and the new coupling term $\sim \alpha D_e$ tells us that it is about 137 times stronger than the coupling D_e of the electron masses. The reference allows a value in a range $D_e/(137{\pm}10)$, so αD_e is tentative.

2.3 Massive bosons

A double circular resonance gives $N = P$, and since the Higgs potential is unique, $N P$ is independent of the particle. This circular resonance creates a radial wave, so the mass must be reduced by a factor π to extract the radial equivalent (just as with $2\pi N P \approx$ integer for the mixed resonance we have $N P$ in the mass formula); a mixed resonance imposes a phase constraint between its two components; so we need a correction to ensure the internal coherence of the phases of these particles. At a single potential, they cannot admit a mass μ, which must therefore be integrated into the formula to reason at constant X_e, which gives

$$m = \frac{m_e}{m_e - \mu_e} \times \frac{X_e}{k\,\pi \left(\dfrac{1}{N^2} + K\,D_b\right)^3}\,, \tag{11}$$

where m_e is the electron mass and D_b a boson-dependent coupling; and where the small k in the denominator represents the correction quoted above. After a first estimate of the couplings, and assuming charge transport, by the simple but relatively long reasoning detailed in [8] we deduce two couplings composites of α and D_e, identical for Z^0 and $W^\pm$

$$D_{WZ} = \frac{\alpha^2}{1+\alpha^2} + \frac{\alpha\,D_e}{2\,(1+\alpha^2)} - \frac{D_e^2}{6\,(1-\alpha^2)}\,, \tag{12}$$

and very close but different for the H^0

$$D_H = \frac{\alpha^2}{1+\alpha^2} + \frac{\alpha\,D_e}{2\,(1+\alpha^2)} - \frac{D_e^2}{1-\alpha^2}\,, \tag{13}$$

where α^2 represents a free field and the denominators are given by infinite interaction loops. We also showed (see also section 8.1) that the small k of (11) must be computed from

$$k^3\,\frac{\pi}{144} = 266\,D_b\left(\frac{\pi}{k}\right)^{1/3}\,, \tag{14}$$

where D_b is the related boson coupling and the resonances (144 and 266). On this basis, Table 4 shows the harmonics and calculated masses (reference PDG 2023*).

Table 4: Massive bosons resonances (MeV/c^2).

-	P=N	K	Calculated	Reference
$W^\pm$	12	-2	$80,384.9$	$80,385\,(15)$
Z^0	12	-7	$91,187.3$	$91,187.6\,(2.1)$
H^0	12	-19	$125,206$	$125,250\,(170)$

We also checked in [8] the phase loop between the circular path, $N^2 = 12^2$, and the radial path in 266 with the three values of $K \in \{-2, -7, -19\}$. Phase coherence with -7 and -19 is trivial since $12 = 19 - 7$. The $W^\pm$ loop is also synchronous with $K = -2$, since $266 - 2$ is a multiple of 12, of which 2 is a sub-multiple. Internal phase coherence therefore allows all three resonances to exist. On the other hand, reasoning in the same way and on the same model, the other divisors of 266, $K \in \{-133,\,-38,\,-14\}$ do not check.

It is important to see that it is "really" the fine-structure constant in the expressions of D_{WZ} and D_H, and not a close value; because if we replace this value by $1/137$, the mass of the Z^0 becomes $91.2097\,\mathrm{GeV/c^2}$, a factor of 10 outside the experimental uncertainty. Similarly, the specificity of D_H is necessary; without it we would get $M_H = 126.5\,\mathrm{GeV/c^2}$.

2.4 Boson widths

With (11), a resonance formula we calculate pole masses; we should therefore be able to calculate their total widths from the resonance geometry. There is no way of varying N, P, which are integers, nor D, which depends on charges; widths should therefore be given by a displacement of charges giving $K \to K + \Delta K \to \Delta m$ needed for the resonance to blow.

These three particles carry multiple charges organized in a minimal way; at the ends of a simple line for the $W^\pm$ and Z^0, and at the vertices of a tetrahedron for the H^0 (giving the difference between D_{WZ} and D_H). Then for the first two, $\pm 1/2$ on the radial axis and half of $1/12$ from the circular path gives

$$W^\pm \to \Delta K = \left(1 + \frac{1}{24}\right) \to \Gamma_W = 2.0857\,\mathrm{GeV/c^2}\,, \tag{15}$$

in great agreement with the reference $2.085 \pm 0.042\,\mathrm{GeV/c^2}$.

$$Z^0 \to \Delta K = \left(1 + \frac{1}{24}\right) \to \Gamma_Z = 2.4684\,\mathrm{GeV/c^2}\,, \tag{16}$$

*Particle Data Group

1% less than the reference (2.4952 ± 0.0023 GeV). And for the H^0, the tetrahedron is stable in K but the six line of forces can stand a displacement of $\pm 1/144/2$, so

$$H^0 \rightarrow \Delta K = \frac{1}{144 \times 6} \rightarrow \Gamma_H = 4.11\,\mathrm{MeV/c^2}\,, \tag{17}$$

also to 1% of the theoretical reference. So at first order, the widths are in good agreement with experiment and theory. A small difference remains for the Z^0, which calls for a complement that can only depend on the charges it transports, assuming $2 \times \pm e/3$ and/or $2 \times \pm 2e/3$, gives the fit:

$$\Delta K = \left(1 + \frac{1}{24} + \frac{1.5}{137}\right) \rightarrow \Gamma_Z = 2.4946\,\mathrm{GeV/c^2}\,. \tag{18}$$

The H^0 width will be re-discussed in section 5.6.

2.5 Neutrinos

The masses of neutrinos are much lesser than the constants X_e and X_α, so we cannot fit the formula parameters in the same way as for other particles. We suppose an inversion and fit the mass formula parameters from constraints that then seem logical:

- There is a progression of α and D_e powers in the couplings, up to D_e^2 and α^2 for the bosons. So no new coupling (use D_e and/or α), and we are looking for a negative power of α or D_e.
- Similarly there is a progression of resonances N, P; a unitary resonance is all that is left, we impose $N\,P = 1$ and only K varies.
- Use the lepton mass equation (3) with $\mu = 0$ and the primary field constant X_e (7).
- Assume a resonance conservation law (in-line with section 8.3), and use resonances inherited from the corresponding electron; thus an echo of the related electron N and K constitutes a neutrino K.

The coupling is

$$D_\nu = \frac{2}{\alpha} \approx 274\,, \tag{19}$$

and corresponds to the inverse of the Dirac monopole, and the constraints above lead to Table 5 where the echo of the related electron resonances is obvious:

Table 5: Neutrinos resonances (eV/c^2).

-	P = N	K	Calculated mass
ν_e	1	1/2	0.00310
ν_μ	1	1/(3 − 1/9)	0.00924
ν_τ	1	1/(5 + 1/9)	0.04998

- $K \rightarrow 1/K$, and
- $N = P = 7 \pm 2 \rightarrow 1/(K \pm 1/9)$, with the sign of ± 2.

Table 6 compares the results with the corresponding limits (reference $\Delta m^2{}_{ij}$ 1 σ NO, NuFIT 5.2-2022 – where $\Delta m^2{}_{31} = \Delta m^2{}_{32}$).

Table 6: Comparison to reference data.

Quantity	Calculated	Reference	Unit
$\Delta m^2{}_{21}$	0.0000759	0.0000741 ($^{+21}_{-20}$)	(eV/c^2)^2
$\Delta m^2{}_{31}$	0.002488	0.002511 ($^{+28}_{-27}$)	(eV/c^2)^2
$\Delta m^2{}_{32}$	0.002412	0.002511 ($^{+28}_{-27}$)	(eV/c^2)^2
$max\{m_i\}$	0.0500	≥ 0.0501 ($^{+28}_{-27}$)	eV/c^2
m_{tot}	0.062	$0.06 < m_{tot} < 0.12$	eV/c^2

2.6 The μ_e mass

The μ_e mass can be seen as an artifice since it is needed only for electrons and all particles are supposedly elementary, but its existence is now easy to justify.

Firstly, the calculation of the Sommerfeld constant in [5] requires four dimensions and two rotations. A rotation in four dimensions implies two planes conserved. A cut of a four-dimensional resonance to the three space dimensions (x, y, z) will give a rotation axis, i.e. the magnetic moment axis, say z, then in Table 1 $N = P$ for x and y. But we can make a second cut on (x, z, t) and impose $P = K$ on z, t; if the two rotations are synchronous we get Table 2 (or $P = n\,K$ or $P = K/n$ with n integer which would only affect D_α – but is eventually not needed). From this we need a couple of masses μ_e and μ_α linked by a constant factor because in this process we eliminate one of the two rotations in Table 1, and take the ratio of both in Table 2. It is still possible to make any other cut that will mix space and time differently, but hard to believe that the mass μ can be set to zero or close enough without using large integers for the resonances.

Secondly, we can see it in all non unitary resonances, but in three different ways:

- Like a simple addition for electrons (Table 1).
- With the coupling D_q of quarks (Table 3).
- And integrated into the resonance mass coefficient (11) in the case of bosons (Table 4).

The second form is indirect because here it appears from the ratio μ_α/μ_e when we look at (8) and (10) $D_q = D_e(1 + \alpha)$ means that a scaling in α or $2\,\alpha$ is omnipresent; but when we discuss resonance length ratios it becomes 137 or 68.5.

Now the μ_e mass is part of the primary field and we need to find its resonance. It is understood as one side of the invariant bridge to the secondary field; hence its resonances in the two fields should be synchronous with those of the three electrons. So in order to estimate it we impose:

- A composite resonance compatible with those of all three electrons in both fields, Tables 1 and 2 simultaneously.
- Use of the primary field constant X_e (3).
- No new coupling (D_e and/or α).

As a result, the coupling (best fit) is composite and uses Sommerfeld's constant

$$D_{\mu_e} = (\exp(1) + 1)\ \alpha - \ln(1+\alpha)\,. \tag{20}$$

The logarithm and its base in this expression are typical signatures of cumulative phenomena. The expression below gives the mass in (4), and includes two resonance

$$\mu_e = X_e \left(\frac{7}{2} - \frac{1}{4} - D_\mu\right)^{-3}\,. \tag{21}$$

The fractions are equivalent to two resonances – $NP = 2/7$ and $NP = 4$ – and take the numbers of the primary resonances of the three electrons ($N = P \in \{2,\ 7-2,\ 7+2\}$), and 4 is also the electron resonance of Table 2, compatible with the others as it is a submultiple of the three products NP of this Table.

Finally the coupling of the μ_e mass depends solely on α and mathematically natural constants or functions, meaning that the couple it forms with μ_α "is" an electric charge on one side and looks like a magnetic current on the other.

2.7 Comments

Tables 1 and 2 use four degrees of freedom each, for two mass ratios, hence of no value if considered alone. Tables 3 and 4, on the other hand, use only one variable integer (or two for the u and d), and combine known couplings (α, D_e). With variations using only 2, 7 and 19 in these two tables for 9 particles, we must suppose that there is no freedom here; and neutrinos and electron resonances also fit the same numbers. Last, the μ_e resonance is synchronous of all electrons. Hence a global scheme is present.

Note that for the calculated masses, excluding neutrinos and μ_e, we have

$$|NPKD| < 1\,, \tag{22}$$

which, since we start with a unit-size resonator, should express a geometric constraint limiting the particle spectrum. If we imagine a fourth generation of electrons as a continuation of Tables 1 the next resonance is $N = P = 19-2$ (starting from {2, 7, 19}), and $K = 7$ at the very least (following the progression of Table 1), and this inequality is not verified. The same result applies to quarks since the next product of two numbers from the same set is $N = 7\times 19 = 133$, and P and K are constant Table 3 for the heavy quarks. The impossibility of bosons with masses other than those in Table 4, and using the same resonance model, is verified with the resonance paths coherence in $N = P$ and K (essentially $N = P = 12 = 19-7$ and $266-2$ is multiple of 12).

3 Couplings

3.1 Analysis

Table 2 shows two components of the Sommerfeld constant calculation [5, Eq. (4)], as a reminder:

$$\alpha^{-2} = 137^2 + \pi^2 - \frac{1}{137.5}\left(\frac{1}{2} + \frac{1}{8} \pm \frac{1}{137.5}\left(\frac{1}{2} \pm \frac{1}{8}\right)\right), \tag{23}$$

namely $N = 2^1$ for the electron and $N = 2^3$ for the muon, the inverses of $1/2$ and $1/8$ identified in this calculation as identical resonances in 1 and 3 dimensions; the third resonance, that of the tau $N = 16$ is their product, therefore 3+1 dimensions.

The relation (8) between μ_e and μ_α uses twice the number 137, which implies an underlying origin, as it is one of the two common aspects of the three electrons. Now one way or another all particles discussed so far couple in α, meaning it constrains their resonances; then we calculate the sum of all the *integral and distinct* resonances in N and P (omitting fractions: μ_e, neutrinos, and quarks u and d):

$$\Sigma_{NP} = 2+3+4+5+7+8+9+12+14+16+19+38 = 137\,. \tag{24}$$

It is from this sum that we can first imagine to calculate Sommerfeld's constant using the Bohm-de Broglie model, as it simply suggests that resonance and couplings act in mirror in a finite harmonic system; and again that the full mass spectrum is known. We must then look at the other axis K, and take into account the boson mass calculation which uses submultiples of 266 on this axis. So, again excluding μ_e, neutrinos and the quarks u and d, taking all the distinct K and replacing those of the bosons by +266, the sum

$$\Sigma_K = (2\times 7\times 19) + 2 + 3 + 4 + 5 - 6 = 274\,, \tag{25}$$

is also compatible with a harmonic system between couplings and resonances, where the factor 2 with $\Sigma_{NP} = 137$ would constitute a second level of harmony.

3.2 $\mathbf{D_e}$ and $\mathbf{D_\alpha}$

According to this logic, the three couplings used, intervening at the same level in the mass formulas, should proceed from a unique mechanism and obey the same constraints; their geometrical structures should therefore be similar and their formulation obey the same pattern that we know from Sommerfeld's constant (23), i.e.

$$D^{-2} = a^2 + b\,\pi^2 + \frac{c}{d}\,, \tag{26}$$

with geometric and action constraints between their components, which dictate that

1. a is the integer whose square is closest to D^{-2},
2. b is the integer such that $a^2 + b\,\pi^2 - D^{-2}$ is minimal in absolute value,

3. d is a rotation term where π^2 is suppressed,
4. $|b| > |c/d|$,
5. one of the terms is negative, and
6. all terms are numbers known through resonances.

Then a constrained division of the empirical value gives

$$D_e^{-2} = \Big((7-3)\times(274+19)\Big)^2 + 7\pi^2 - \frac{19\pi}{19-1}\,, \qquad (27)$$

$$D_\alpha^{-2} = \Big((19-3)\times(274+3)\Big)^2 + 2\times\Big(274+19+1\Big)\pi^2 - \frac{19}{4\pi}\,. \quad (28)$$

After reducing a to prime numbers, we make 274, 7 and 19 appear from which 3 is subtracted. We find in the b term of D_α the electron wave signature present in α with $275\,\pi^2$, but augmented of 19 like 274 in the a term of D_e. There is a neat numerical recurrence between the couplings, a form of similarity between D_e and D_α, and a double connection with α (and two more if we also count $274 = 2 \times 137$). As expected, it agrees with a one to one mirror effect between couplings and resonances.

3.3 Ghost coupling

The three couplings appear to take the same resonances as particles, with 274 twice and 274 + 1; they include two isolated rotations $1\,\pi^2$ and $7\,\pi^2$, the expected third $19\,\pi^2$ is absent; it is found in the resonance of two quarks t and b, $K = -19$ to calculate the mass of the H^0, and twice added to 274. We find 274 twice in the a terms and 137 only once. So we are missing a coupling that will include 137 like Sommerfeld's constant and $-19\pi^2$, the latter negative to fit subtraction at the denominator of the term d of D_e where the $1\,pi^2$ and $19\,\pi^2$ subtract. The missing elements give a and b and a spin 2 gives c:

$$D_p^{-2} = 137^2 - 19\pi^2 + \frac{4\,\pi}{19}\,, \qquad (29)$$

each term of which and/or its inverse is present in the other couplings formulas, therefore adds no new resonance, and which force has no coupling effect on the calculus of masses (so can we guess at this stage).

3.4 Comments

We note that all the conditions listed in section 3.2 are verified for three couplings, i.e. less than one chance in 10^5 for a random draw of three values. For D_p the point 1 is violated; this is imposed by +137 positive and $-19\,\pi^2$ negative, without which there would be no consistency either with α or with the terms in 19 of D_e and D_α.

The geometrical form and connections of the couplings extend the underlying unity found in masses, and imply the non-separability of the forces.

4 The Planck mass

4.1 Notations

From now on, we shall use the Planck mass and length in their original formulations:

$$m_p = \sqrt{\frac{h\,c}{G}}\ ;\ l_p = \sqrt{\frac{h\,G}{c^3}}\,, \qquad (30)$$

denoted in lower case. We shall be using SI units. The values of the constants used are

$$G = 6.67430\,(15) \times 10^{-11}\,\mathrm{N\,m^2\,kg^{-2}}\,. \qquad (31)$$

and by definition

$$h = 6.62607015 \times 10^{-34}\ \mathrm{J\,s}\ \ ;\ \ \mathrm{c} = 299792458\,\mathrm{m\,s^{-1}}\,. \quad (32)$$

We shall also use the Planck mass integrating the constant of quantum theories $\hbar$ and the Einstein constant $8\pi\,G$:

$$M_p = \frac{m_p}{4\pi} = \sqrt{\frac{\hbar\,c}{8\pi\,G}} = 4.341358(47) \times 10^{-9}\,\mathrm{kg}\,, \qquad (33)$$

denoted capitalized. The value of the constant X_e (3) is in SI:

$$X_e = 1.451999775331 \times 10^{-32}\,\mathrm{kg}\,. \qquad (34)$$

To avoid confusion, the subscript p will be used for quantities calculated with the classical formulas, and with the subscript ω when calculated from the harmonic system.

4.2 Unity and GR-QM reverse symmetry

The denominator of mass formulas relates a resonance expressed as a length $(1/N\,P)$ within a resonator of length 1 – equivalent to stress or pressure – to a force expressed as a coupling $(K\,D)$. In terms of Einstein's field equations, this is the fundamental unity of force, stress and energy: here, mass is stress, and therefore, by a natural extension, all forms of energy. There is a trivial geometric and quantitative symmetry between GR and QM, which is *a priori* compatible with the preceding results, since the three following relations must be compatible with the harmonic system:

- Newton's force in its natural quantum form, as each mass ratio must be physically homogeneous:

$$F = -\frac{G\,m_1\,m_2}{r^2} = -\frac{2\pi\,\hbar\,c}{r^2}\,\frac{m_1}{m_p}\,\frac{m_2}{m_p}\,. \qquad (35)$$

- The relation for a given mass between a Schwarzschild radius and a Compton wavelength:

$$R_S\,\lambda = 2\,l_p^2\,. \qquad (36)$$

- Or, in the form of three unitless ratios,

$$\frac{m}{m_p} = \frac{l_p}{\lambda} = \frac{R_S}{2\,l_p}\,. \qquad (37)$$

The volume at the denominator of the mass formula then represents two inverse quantities, depending on whether we see $1/N\,P$ in the denominator or its inverse in the numerator. By writing it in the following form

$$m = X\left(\frac{N\,P}{1+N\,P\,K\,D}\right)^{+3}, \tag{38}$$

the couplings appear as a mirror effect characterized by the product $N\,P\,K\,D$ which, according to (36) in particular, must be centered on a resonance corresponding to the Planck particle. Its mass should therefore be calculable with

1. a mass formula,
2. what is missing, 266 and D_p,
3. and what is universal, X_e and D_e,
4. taking into account a dispersion in $4\,\pi$,

because then X_e cancels in the ratio m/m_p of (35) and it expresses only stress ratios in a unique harmony. We find

$$M_\omega = X_e\left(\frac{D_e}{266^2}+D_p^4\right)^{-3} = 4.341421\times 10^{-9}\,\text{kg}\,, \tag{39}$$

which is the Planck mass M_p (33).

4.3 Comments

Now the harmony, its formulas and its two universal parameters cover the twenty-one orders of magnitude separating the mass of the Planck particle from that of the electron – or thirty with neutrinos. It shows once again the underlying unity, and that the form given to the couplings is correct as well as their assumed connections.

5 Toward the origin

While the origin of the resonances is not understood there is all the material needed in the mass M_ω (39) with two couplings D_e and D_p based respectively on $\Sigma_{N,P} = 137$ and $\Sigma_K = 274$, a term in 266, and the constant X_e. It suggests that we are close to the end and that the next step is to find an origin of the particle resonances; for this we need to find the constraints that apply. Since the Planck mass defines gravity we need to find-out how it defines space-time locally and globally and why it oscillates.

5.1 Classical anomaly

The calculation of M_ω (39) uses two couplings $D_e/266^2$ and D_p^4; two orthogonal forces and lengths, respectively the sine and cosine of an angle

$$\Omega = \arctan\left(\frac{D_e}{266^2}\times\frac{1}{D_p^4}\right) = 1.33509... \approx \frac{4}{3}\text{rad}\,. \tag{40}$$

Now assume a spherical object with radius R greater than its Schwarzschild radius R_S; in the Newtonian gravity case, for a test particle at $D < R$ which wave function is $\psi = e^{i\phi}$, the phase shift $\Delta\phi$ in R for the momentum $\hat{p}\,\psi$ along $\vec{r}$ would only depend on mass and obey:

$$\int_0^R 4\pi\, r^2\,\rho(r)\,dr = \Lambda\int_D^R d\phi\,, \tag{41}$$

where the right-hand side is just the phase shift between D and R, $\rho(r)$ the energy density in r, and Λ a constant independent of R and R_S. Above all, this equation represents the effect of one phase variance, that of the massive object, say S, on another, that of the particle momentum. Now, the constitutive stress of this object is locally $\rho(r) = S/\pi$ because, firstly, there is here identity between stress, energy and phase variance, and secondly, the point of no return is π; so (41) can be written in unitless form where ϕ, S and Λ are three angles:

$$\int_0^R 4\,\pi\left(\frac{S}{\pi}\right)^2 d\left(\frac{S}{\pi}\right) = \Lambda\int_D^R d\phi\,. \tag{42}$$

So if R tends to R_S, the integral of the left-hand side tends to $4\,\pi/3$ (S tends to π) and that of the right-hand side to π, hence $\Lambda = 4/3$. Now we compare two forces in (40) to their effects in (42) – *where there is identity*, then in the Newtonian gravity case we should find $\Omega = 4/3$. It is easy to see that the difference is not due to the precision of G, hence neither D_e nor D_p. It only expresses the incompleteness of our knowledge of the forces structure – *and therefore of their effects*. Then, since all energies gravitate we assume a complement also coming from the harmonic system representing all possible interactions through D_e and the powers of D_p, which should cover all the oscillator forms, known or not; thus a quantized series $h_i\,D_p^i$ such that:

$$\sum_{i=0}^{n}\frac{h_i\,D_p^i}{D_p^4}\times\frac{D_e}{266^2} = \tan\left(\frac{4}{3}\right), \tag{43}$$

where $h_0 = 1$ for the Planck mass, and n any, possibly infinite.

5.2 Method

The series in (43) will be used as a probe; for this we need to estimate its terms one by one (h_1, then h_2, etc...). But we do not yet know what to search as there is *a priori* no experimental data to rely on. Still, each step must bridge part of the gap and reflect the unity that has so far been expressed through couplings and resonances; geometric shapes, a topology covering all forms of the oscillator as each of the products $D_e\,D_p^i$ corresponds to an increasingly large coupling, and the whole to a nested topology. So

- From the couplings at its origin, the sequence should talk of Sommerfeld's constant and particle resonances. These aspects should make its terms identifiable, hence logic imposes to recognize what we find.
- There is no turning back, then each term should reduce the residual by roughly 2 orders of magnitude – or maybe more.

- The precision of each term is infinite; the very structure of the sequence as a quantized oscillator implies that approximation is illusory.

These constraints severely limit the field of exploration; we use them with the following method:

1. At step n consider the residue, and divide by D_p^n.
2. Recognize what it is, round up or down to significant number(s) in line with $n-1$ and compute the residue.
3. If the residue is small enough go to step 1 for $n+1$, and continue with the next quantity of similar kind.
4. If not it may be a border then if h_n describes a known shape go to step 1 for $n+1$; or h_n is wrong, then go back to step 2 and make a better guess.

Two high precision online calculators [15] and [16] are used to calculate and check.

5.3 Sector one, particle resonances

M_ω corresponds to

$$h_0 = 1 \quad [+1.9\times 10^{-3}]\,, \tag{44}$$

with the residue with respect to tan(4/3) in square brackets.

$$h_1 = -1 \quad [+8.4\times 10^{-5}]\,, \tag{45}$$

a unit resonance represents a massless particle that can be identified with either a photon or neutrino(s).

$$h_2 = -3-4 \quad [-2.2\times 10^{-6}]\,, \tag{46}$$

is a little more complex, -4 is identified to the resonances of the electron (NP = 4 Table 1), and -3 with the P of quarks (Table 3) – two radial components linked to the electric field, the latter to fractional charges. In addition $-4-3=-7$, twice the first part of the μ_e resonance $7/2$, and 4 is the inverse of $1/4$, the second part.

$$h_3 = +25 \quad [+5.1\times 10^{-8}]\,, \tag{47}$$

the muon resonance (NP = 25 Table 1, and NP = 24 Table 2 is close to optimum).

$$h_4 = -81 \quad [-2.7\times 10^{-9}]\,, \tag{48}$$

the tau resonance (NP = 81 Table 1, and NP = 64 Table 2 is also in the optimum range).

$$h_5 = 2\pi\left(7+14+19+38+\frac{38}{19}+\frac{14}{7}+\frac{38}{14}+\frac{19}{7}\right) \quad [2\times 10^{-11}]\,, \tag{49}$$

the sum of quarks'N (Table 3) by 2π for circular paths.

$$h_6 = -556 = -8\times 69.5 \quad [5.7\times 10^{-14}]\,, \tag{50}$$

which, by its position must correspond to the gluons eight degrees of freedom; without mass it would be either 1 or 8×1, this a point to understand. The last harmonic of this sector is

$$h_7 = -217 = -144\times\frac{3}{2}-1 \quad [3.9\times 10^{-17}]\,. \tag{51}$$

The first term -144 identifies the resonances of the three massive bosons (Table 4) with a factor of 3/2; and the second either the photon or the neutrino(s) with -1.

The resonances $N,\ P$ of all particle of the Standard Model are entirely covered by this sector and simple to identify – including massless particles or supposed so. Note 1) that all h_i give directly comparable quantities, irrespective of the power associated with D_p; 2) that within a single harmonic all terms have the same sign, otherwise the result would be meaningless; 3) that the presence of 2π for quarks is consistent with the inferred geometry, as is its absence for electrons and massive bosons; 4) that the assumed logic of generating the Sommerfeld constant is verified for particles of known mass; 5) the μ_e mass resonance may also be here in h_2 (the part $7/2$); and 6) the unitary resonance of h_1 or h_7 justifies the neutrino mass calculation in section 2.5.

5.4 Sector two, spheres

The second sector starts with spherical coefficients of dimensions 4 to 7, with phase variances according to the template of the M_ω anomaly, then similar but inverted coefficients.

$$h_8 = -2\pi^2-\frac{1}{\pi} \quad [7.2\times 10^{-20}]\,, \tag{52}$$

the four-dimensional sphere surface coefficient ($2\pi^2$) and a phase variance ($1/\pi$).

$$h_9 = -\frac{8\pi^2}{15}+\frac{1}{2\pi} \quad [1.2\times 10^{-22}]\,, \tag{53}$$

the five-dimensional sphere volume coefficient ($8\pi^2/15$) and a phase variance ($1/2\pi$).

$$h_{10} = -\frac{\pi^2}{6}+\frac{3}{2\pi} \quad [-5.7\times 10^{-24}]\,, \tag{54}$$

both a) the six-dimensional sphere volume coefficient ($\pi^3/6$) divided by π, b) its surface coefficient divided by 6π, and c) curiously, the Riemann function, $\zeta(2)=\pi^2/6$, and a phase variance ($+3/2\pi$).

$$h_{11} = +\frac{3}{2}\times\frac{16\pi^3}{105}+\frac{1}{\pi} \quad [1.7\times 10^{-27}]\,, \tag{55}$$

the seven-dimensional sphere volume coefficient ($16\pi^3/105$) times $3/2$, i.e. $16\pi^3/70$, and a phase variance ($+1/\pi$). The same factor $3/2$ is also present in h_7.

$$h_{12} = -\frac{1}{\pi} \quad [-6.3\times 10^{-29}]\,, \tag{56}$$

a simple phase variance, which defines a boundary.

$$h_{13} = +\frac{2}{5\,\pi^2} - \frac{\pi}{2} \quad [3.3 \times 10^{-32}]\,, \tag{57}$$

an inversion of h_9, with $\pi \to \pi^{-1}$ by multiplying the first term by $3/4$, the inverse of the original tangent.

$$h_{14} = -\frac{1}{4\,\pi} - \frac{1}{\pi^3} \quad [-5.6 \times 10^{-34}]\,, \tag{58}$$

the inverse of the surface coefficient of a three-dimensional sphere ($4\,\pi$), and that of a six-dimensional sphere (π^3).

This sector, like the others, identifies stress coefficients and therefore forces and shapes. Finding spherical coefficients and phase variance terms can be identified with forces in at least 7-dimensional space. The signs of the components in (and between) harmonics are not always the same, possibly indicating opposite effects.

5.5 Sector three, wave and coupling

Convergence in this sector is extreme.

$$h_{15} = +\frac{1}{2^2} + \frac{1}{133\,\pi + \frac{\pi}{6}} \quad [2.5 \times 10^{-40}]\,, \tag{59}$$

two phase variances (or inverted resonances).

$$h_{16} = \frac{-1}{266^2 - 69.5^2 - 137 - \frac{3}{2} \times \left(1 + \frac{1}{69.5} - \frac{\pi}{8 \times 69.5 + 3}\right)} \quad [3.8 \times 10^{-51}]\,, \tag{60}$$

corresponds, by its shape, to the difference of the squares of two couplings ($A^2 - B^2$), separating for instance the three terms in 69.5 from the others.

5.6 Sector four

The fourth sector is separated from the third by seven null harmonics (h_{17} to h_{23} inclusive) and begins with two identically shaped resonances that seem to complement each other.

$$h_{24} = -3^3 - \frac{2\,\pi^3}{3^4\left(1 - \frac{1}{2\times 7}\right)} \quad [-5.2 \times 10^{-56}]\,, \tag{61}$$

a resonance term associated with a coefficient in π^3 that must be associated with a dimension. Then $h_{25} = 0$, and

$$h_{26} = +2^2 + \frac{3\,\pi^3}{2^4\left(2 - \left(\frac{3}{2}\right)^3 \times \frac{1}{2\times 19}\right)} \quad [5.7 \times 10^{-60}]\,, \tag{62}$$

whose form is an almost exact copy of the previous one, reversing 3 and 2, and 7 and 19. Then $h_{27} = 0$ and finally

$$h_{28} = -\frac{144}{\pi^2} + \frac{1}{24} + \frac{1}{(144+1)\times 6\,\pi} \quad [3.0 \times 10^{-68}]\,. \tag{63}$$

This harmonic corresponds to the three bosons resonance (i.e. $N\,P = 144$) and their resonance widths ($1/24$ and $1/144/6$) seen in the radial direction. The last term being different from the expected one, we recalculate the H^0 width:

$$H^0 \to \Delta K = 1/((144+1)\times 6) \to \Gamma_H = 4.079\,\mathrm{MeV/c^2}\,, \tag{64}$$

which, if compared to (17), is closer to the theoretical value at $125.206\,\mathrm{GeV/c^2}$.

6 Coherence

The sequence can only be proven based on a detailed knowledge of the geometry it defines; we are not there, we do not know how it works or whether it ends or not. We can, firstly, find internal correspondences and, secondly, relate it to known quantities. This is the purpose of this section, whose aim is to get a first estimate of coherence with the harmonic system, in particular the mass spectrum.

6.1 First points

We recognize many structuring points; a non-exhaustive list:

- First sector: All resonance numbers (N, P or NP) of massive particles are present with two well-defined orders, 1) that of total resonance lengths, and 2) that of the internal couplings progression in the primary field, and therefore groupings either in the same zone or in the same harmonic, the resonances of particles with similar properties.
- First sector: Similarly we find first all radial resonances (from h_2 to h_4), and then rotations (with h_5 and h_7); mixed quark resonances are split in two between h_2 for the radial part P, and h_5 for rotations N.
- First sector: So, having assumed that at this level the forces and their effects are one, which leads to equation (43), we have complemented the structure of the forces with the known structure of their effects, the resonances.
- Second sector: Contains four spherical coefficients, h_8 to h_{11}, in order from 4 to 7 dimensions. Then what identifies with interactions between these structures in h_{13} and h_{14}, and a single phase variance h_{12} in the middle that looks either like the interaction center between these spaces, or a pure absorber in 8 dimensions.
- h_{15}: We find $133 + 4 = 137 = \Sigma_{NP}$, inverting the two main terms and removing π and $\pi/6$.
- h_{15}: The numbers 4, and $133\,\pi = 7\times 19\times\pi$ correspond respectively to the resonances of electrons and quarks. So this harmonic is linked to the fermionic wave.
- h_{15}: the term $\pi/6$ is a phase advance for $133\,\pi$; if it corresponds to an inverted length $\pi/6\,\pi^2$ we get $133 + 6 = 139$, the full resonance spectrum ($\Sigma_{NP} = 137$ plus the two unit resonances) – excluding $h_6 = 8\times 69.5$, but $139 = 2\times 69.5$, the same ratio as between Σ_K and Σ_{NP}.

- h_{15}: 133π is a harmonic of quark resonances 7 and 19 (plus a factor of 2 for charges 2/3), and $\pi/6$ a phase advance giving a negative length; so $K = -6$ Table 3.
- h_{24} and h_{26}: The two phase advances in the denominator multiply to give 133 and 266, depending on how the factors 2 is considered.
- h_{24} and h_{26}: Taking into account the factor 2 in the denominator of the second, as well as the ratio $3^3/2^3$ we obtain 27 and 8, their difference is 19. There are also 7 and 19, the two rotations of D_e and D_p respectively.
- h_{28}: The bosons resonance and widths. This harmonic therefore represents the Higgs field potential – unique as assumed – and h_{28} is complete and in agreement with the calculation of boson masses and lifetimes.

Such structure means an extremely entangled system where each element has a specific role – a global equilibrium working as a whole, coherent and inseparable.

6.2 The electrons, h$_6$ and h$_{16}$

We find 8×69.5 in h_6, which is rather strange as we expect gluons supposedly massless. Conversely, meson spectroscopy has been suggesting a monopole (e.g. [1]) for several decades without finding it, and we could also write $h_6 = 8\times1+8\times68.5$. But we also find 69.5 three times in h_{16}, twice in the denominators and 69.5^2, which makes it unbreakable; but suggests considering

$$69.5^2 = 68.5^2 + 137 + 1^2 \,, \tag{65}$$

by the similarity of this expression with the ratio between the two mass constants μ_e and μ_α given by the empirical relation (8), except for the last term for which we would expect 2 instead of 1. In Table 1, the resonances N and P are 2, $7-2$ and $7+2$, while in Table 2 we have 2^1, 2^3 and 2^4 for N. These two tables represent the primary and secondary fields. So the 1^2 divides to give resonances 2, with Table 2 rotations in π for P and radial terms for N; and Table 1 only radial components for 2 (mixed with 7 if it is circular). Then divide 69.5 by π, invert each term of (65) replace 1 by 2π, and the sum of the inverses gives a ratio of resonance, therefore of masses:

$$\left(\frac{69.5}{\pi}\right)^2 \to \frac{\pi}{2} + \frac{\pi}{137} + \left(\frac{2\pi}{137}\right)^2 , \tag{66}$$

is the ratio μ_α/μ_e (8). This expression also corresponds term to term to that of Sommerfeld's constant (23) and to the logic to its calculus, but in an inverse manner:

- $(2\pi/137)^2$ for 137^2, the electron pulsation.
- $\pi/137$ for π^2, the electron spin,
- and $\pi/2$ for $1/137.5 \times (1/2...)$, the wave.

Consequently, this relation must be reflected in the difference between X_e and X_α as well as in the composite coupling D_{μ_e} (20); considering those as two pressure fields, each being a dynamic transformation of the other, and inverting the relation (8) by taking into account the common share of the resonances of the three electrons leads to the following semi-empirical formula:

$$\frac{X_e\left(1-\exp(1)\,\alpha^2\right)+X_\alpha\left(1+\exp(1)\,\alpha^2\right)}{X_e\,(1-\alpha)-X_\alpha\,(1+\alpha)} = \frac{137^2}{2\pi}\times\left(1-\frac{\pi}{137}\right), \tag{67}$$

whose relative accuracy is 1.4×10^{-8}, and then relative errors of 4.8×10^{-12} on X_e and X_α in opposite directions, better than the uncertainty range on lepton masses (3×10^{-10} for the electron). The formula used here for α is expression (6) of [5].

The left hand side contains α, which is also found in the D_{μ_e} coupling (20), as well as the basis of the natural logarithm. The main term, $137/2\pi$ of the right hand side is modified by $(137-\pi)$, which includes a phase advance; we find again the logic of the calculation of the constant α [5] with $137^2/2\pi$ for an electron pulsation and a phase delay $\pi/137$ per pulsation corresponding to the spin, and we obtain a resonance length $\sqrt{137^2+\pi^2}$ where the fractional wave terms of α, which are related to the electron movement, are naturally absent. Both expressions (8) and (67) therefore speak of a dynamical shift between the primary and secondary fields, which corresponds to electrodynamics and its coupling.

6.3 The Planck length

The Planck length is identified to the maximum resolution and is expressed in units of length. But here it may be inscribed in the denominator of the mass M_ω, which is a pure number. We will therefore calculate the Planck length as an angular resolution independent of the system of units – even though the ice becomes thin as it questions units systems.

In h_{15} we recognize the fermion wave, which is obvious, and h_{16} as the universal coupling forming particles on the surface of a 4D sphere defined by h_8 dominating the first sector, for we can write it $h_{16} = A^2 - B^2 \sim m^2c^4 = E^2 - p^2\,c^2$. They must then define the Planck length or Planck time, which we must be able to calculate with very good accuracy since this sector covers 17 orders of magnitude. Starting with h_{15}, we consider 4 and 133π as resonances and $\pi/6$ as a phase advance, and calculate an uncertainty from distinct paths; each path corresponds to a synchronicity S:

- 4 is the electron resonance, also present in the muon and tauon, and defines a 2π cycle. The first length is therefore a quarter of 2π.

$$S_1 = \frac{\pi}{2}\,. \tag{68}$$

- 133π, is directly a length so

$$S_2 = 133\,\pi\,. \tag{69}$$

- The phase advance $\pi/6$ desynchronizes the two resonances. Combine it with 1/4, the length to consider is:

$$S_3 = \frac{\pi}{6} \times \frac{1}{4} = +\frac{\pi}{24}\,. \tag{70}$$

- It remains to combine the three terms; $\pi/6$ represents a phase advance for 133 and shortens its length; the harmonic h_5 is a multiple of 2π so since 133 is multiplied by π and 6 divides it, for a full turn this makes a length $2\pi \times (133 - 1/3)$, which applies to the denominator of 1/4. A simple phase advance gives a negative quantity, hence a minus sign:

$$S_4 = -\pi \left(2^3 \left(133 - \frac{1}{3}\right)\right)^{-1}\,. \tag{71}$$

To obtain a quantity relating to order zero of the sequence, i.e. relative to one unit, we take into account the coupling D_p^{15} corresponding to h_{15}, which gives:

$$L_0 = \frac{D_p^{15}}{S_1 + S_2 + S_3 + S_4} = 2.2856968.. \times 10^{-35}\,\text{rad}\,. \tag{72}$$

Then h_{16} is a coupling that modifies L_0, also a length and no degrees of freedom, but we have to unfold rotations to obtain a full length.

$$\frac{\pi}{8 \times (69.5 + 3/8)} \to 8\pi^2 \times (69.5 - 3/8)\,, \tag{73}$$

where the sign of the phase advance (3/8) is inverted to obtain the corresponding length, and for the other term

$$\frac{1}{69.5} \to 69.5\,\pi\,. \tag{74}$$

Those allow us to calculate a quantity h_{16}^* by making the above replacements in the expression of h_{16}. We need to add a geometric factor to h_{16}, since it is also this coupling that compresses the surface of the 4D sphere h_8. Then, as h_{16} depends on D_p^{16}, we multiply by D_p to obtain a value relative to L_0, which gives a correction that may seem marginal

$$\frac{h_{16}^*\,D_p}{2\,\pi^2} = -5.0462626214390 \times 10^{-9}\,. \tag{75}$$

Then by posing

$$L_\omega = \frac{D_p^{15}\,\sqrt{\pi}}{S_1 + S_2 + S_3 + S_4} \times \left(1 + \frac{h_{16}^*\,D_p}{2\,\pi^2}\right), \tag{76}$$

we obtain the unreduced Planck length

$$L_\omega = 4.051292235148901 \times 10^{-35}\,\text{rad}\,, \tag{77}$$

Using M_ω to cancel the uncertainty on G, we get Planck's constant, $h = m_p\,l_p\,c$ with a relative precision of 6×10^{-13}:

$$4\pi\,M_\omega\,L_\omega\,c = 6.626070150004 \times 10^{-34}\,\text{J s}\,. \tag{78}$$

The fact that the Planck length is calculated in this way makes it independent of the system of units. We calculate an angular correction and speak of the GR-QM symmetry given by the relation

$$\frac{R_S\,\lambda}{2} = l_p^2 = L_\omega^2\,, \tag{79}$$

which is then read in steradian (or radian^2), where $R_S\,\lambda/2\,\pi$ is the product of the two half-axes of an ellipse of invariant surface (independent of the particle) inscribed on a sphere of unit radius seen from its center; in other words, the angular resolution in a three-dimensional space – the surface of an ellipse is $\pi\,a\,b$, in agreement with the square root of π in the expression (76). The term on the right is therefore a solid angle and $L_\omega/\sqrt{\pi}$ the angle of the cone that defines it, both of which are independent of the system of units (see also section 7.1). Now we can calculate Newton's constant with the precision of the constant X_e, equivalent in principle to that of the electron mass; using $G = L_\omega\,c^2/4\,\pi\,M_\omega$ we get:

$$G = 6.67410788487\,(180) \times 10^{-11}\ \ \text{m}^3\,\text{kg}^{-1}\,\text{s}^{-2}\,. \tag{80}$$

The above decimals are the same if we calculate $G = L_\omega^2\,c^3/h$ (which is not guaranteed at all as (80) depends on M_ω), the next differs in accordance with the residual error on h (78). The Bohr radius a_0 is then also a pure number:

$$a_0 = \frac{\hbar}{\alpha\,m_e\,c} = \frac{2\,M_\omega}{m_e} \times \frac{L_\omega}{\alpha}\,, \tag{81}$$

because in this expression the mass ratio is a harmonic ratio. Consequently, the interpretation of L_ω holds because α is calculated as the inverse of a resonance length, like L_ω.

6.4 Space-time and couplings

The first sector of the h_i gives the particle resonances, $N\,P$, as a product or separately, meaning that the resonances are part of the structure of space-time; but nothing about their couplings and K, which play at the same level in the mass formulas. Resonances are given in a specific order; for massive particles whose resonances are not unitary, the couplings increase with the i index and mix D_e and α. Hence couplings and K should also be inscribed in the space-time structure in the same order.

When calculating Ω the angle $4\pi/3$ is in 3D space as well as the phase reversal of π. So there is nothing here about space-time and $3 + 1D$, which would seem to be mandatory. A resonance in space-time means a period, the time needed for a resonance to loop which is a space-time interval; we can then use the standard invariant

$$c^2\,t^2 - r^2 = c^2\,\tau^2\,, \tag{82}$$

where τ is a particle period and defines, for this particle, a hyperboloid – and is reminiscent of de Sitter space. Then we pose R and u in hyperbolic coordinates

$$r = R\cosh(u)\ \ ;\ \ c\,t = R\sinh(u)\,. \tag{83}$$

The ratio between space and time is

$$\frac{r}{c\,t} = \coth(u)\,, \tag{84}$$

which is independent of R. Then for the angle Ω (40) notice

$$\coth\left(\Omega^{-1}\right) \approx \frac{\pi}{2}\,, \tag{85}$$

close but not equal, and $\cot(\pi/2) = 0$; the meaning of which is that the ratio of forces in M_ω does not fit flat space-time, so let us check what is missing. With the h_i we get the $N\,P$s which response in the mass formulas are the $K\,D$s, and all this is perfectly ordered since we cannot mix the resonances and couplings at random. Then, in order to find the $K\,D$s' origin we should complement a second series as follows:

$$A = \arctan\left(\sum_{i=0}^{n} c_i \times \frac{D_e}{266^2\,D_p^4}\right), \tag{86}$$

with n any, where the c_i should complement the mass formulas; so that

$$\coth\left(A^{-1}\right) = \frac{\pi}{2}\,, \tag{87}$$

and eventually relates to forces meaning that space-time is flat, because then

$$\cos\left(\coth\left(A^{-1}\right)\right) = 0 \;\;;\;\; \sin\left(\coth\left(A^{-1}\right)\right) = 1\,. \tag{88}$$

The resolution logic for this series is basically the same as for the h_i; but we know a little more of what to search. The first sequence gives the particle resonances in order of mass and of increasing gravitational couplings D_p^i; we should logically expect a similar order with the couplings α and D_e. Then since $D_e \approx 16\,\alpha^2$, the gain at each step may be rather chaotic but show the same progression as for the h_i, with a *known* coupling responding to $D_e\,D_p^i$. The two couplings giving a minima the progression α, D_e, $\alpha\,D_e$, and D_e^2; respectively that of μ_e, electrons, quarks, and bosons; we should not use α^2 as it represents infinite loops in the boson mass couplings D_{WZ} and D_H. On this basis the empirically fit sequence is

$$c_0 = +1 \quad [3.2\times10^{-3}]\,. \tag{89}$$

for the Planck particle.

$$c_1 = -\alpha\times\frac{7}{2} = -\alpha\times\left(4-\frac{1}{2}\right) \quad [1.6\times10^{-4}]\,. \tag{90}$$

This is $h_2 = 7$ divided by 2, and the coupling and primary resonance of μ_e, which indirectly responds to h_2, h_3 and h_4. It also decomposes in $4 - 1/2$, where 4 is the electron resonance Table 1 and sub-multiple of all $N\,P$ of Table 2; and a resonance $1/2$.

$$c_2 = -D_e\times\left(\frac{1}{2}+\frac{1}{25}+\frac{1}{81}\right) \quad [6.8\times10^{-5}]\,. \tag{91}$$

The primary coupling and the inverse of the resonances N or $N\,P$ of the three electrons Table 1, though for the electron we would expect $1/4$ instead of $1/2$; we consider it responds to h_2, h_3 and h_4 with D_e.

$$c_3 = -\alpha\,D_e\times\frac{h_5}{4\pi} \quad [1.4\times10^{-5}]\,. \tag{92}$$

The primary field coupling appearing with quarks ($\alpha\,D_e$), and the associated quark resonances N Table 3. So it responds to h_5 (49) but only for the coupling appearing with quarks.

$$c_4 = -D_e^2\times\left(144\times\frac{2}{3}+2-\frac{1}{7}-\frac{1}{19}\right) \quad [3.6\times10^{-9}]\,. \tag{93}$$

The primary coupling specific to bosons (D_e^2) and associated resonances, though multiplied by $2/3$ instead of $3/2$ in h_7 for 144, and the other numbers fit the boson's K. Again it responds to the coupling appearing with bosons except α^2. We have all what we know of, but let us continue.

$$c_5 = -\alpha\,D_e^2\times\left(\frac{7}{2}\right) \quad [7.8\times10^{-11}]\,. \tag{94}$$

Now $c_5 = c_1\,D_e^2$.

$$c_6 = +D_e^3\times\left(\frac{1}{2}+\frac{1}{25}+\frac{1}{81}\right) \quad [9.8\times10^{-12}]\,. \tag{95}$$

And now $c_6 = -c_2\,D_e^2$. We stop here because we do not have enough precision on α to continue (even c_6 is doubtful).

Overall, we have a progression of the primary couplings together with the resonances they apply to – plus maybe a bit more that repeats the same resonances. We notice:

1. That the rotations of quarks appear radially to the associated piece of coupling.
2. That the factor $3/2$ of h_7 is inverted.
3. That the electrons N or $N\,P$ appear as inverses.
4. That nothing comes out for gluons h_6, neutrinos h_1, photons in h_8.

6.5 Connection $\mathbf{h_i - c_i}$

Connecting this sequence to the h_i is not difficult as it obeys the following rules:

1. For a given particle group, the resonances N, P and the strongest part of the associated coupling can be taken from a single element of this suite.
2. Any integer is a resonance $N\,P$ or K, to be taken as is.
3. Any fraction is an inverted $N\,P$ or K, whose sign must be reversed.

With the following consequences:

- The $N\,P$ resonances of electrons is the inverse number of c_2, except for the electron where we get $N = P = K = 2$ for Tables 1 and 2.

- A circular resonance N of a quark is taken in c_3 as radial effect of the same number in h_5.
- The resonances $N\,P$, K of the massive bosons are in c_4, with $3/2$ and two of the Ks inverted.

Overall, we get the N, P, D_{max}, where D_{max} is the strongest part of a particle coupling, and the boson's K. But we can complement the couplings for each particle group with a simple addition of D_{n-1} to D_n:

- The K of the bosons being known from c_4 we use the same number from c_3 to get the part in $\alpha\,D_e/2$; the factor $1/2$ comes from the interaction of two charges.
- For quarks, we get $D_q = D_e + \alpha\,D_e$ taking D_e from c_1.
- For electrons, the coupling is complete from c_2; and we get the electrodynamics coupling α from c_1 – which is also valid for quarks.
- Massive bosons are composites, then α^2 is taken as the square of α from c_1; in agreement with a free field giving the denominators of D_{WZ} and D_H by infinite interaction loops.

We miss the electrons and quarks K, which origin is still unknown. And by the way, the bosons resonance $N\,P = 144 = \left(\left(\frac{3}{2}\times 144\right)\times\left(\frac{2}{3}\times 144\right)\right)^{1/2}$ is the geometric mean of two components from h_7 and c_4.

6.6 Comments

The two sequences h_i and c_i appear to be working together with respect to the particle resonances. We first showed that the angle Ω must be complemented to $4/3$ to get the harmonics N, P, and then that the hyperbolic cotangent of its inverse must be complemented to $\pi/2$ to get a mix of coupling and resonances – both sequences in the same "right" order. Now we have

$$\coth\left(\Omega^{-1}\right) > \frac{\pi}{2} > \coth\left(\frac{3}{4}\right), \tag{96}$$

so M_ω, a black hole, does not reach $\pi/2$, and $4/3$ exceeds it. So the particle spectrum is needed to get to $\pi/2$, and this is done by the coupling α. Consequently, D_p (gravitation) and α (electromagnetism) are complementary to each other for the existence of space-time. Electromagnetism is born from gravitation, which cannot survive without it.

We now have several points justifying the limits of the particle spectrum:

- The first sector of the h_i defines resonances, there are no others.
- It defines the $N\,P$ products of the primary field as a set of elementary oscillators occupying the Planck length. Hence the limitation $|N\,P\,K\,D| < 1$ suggested by the resonances of the primary field makes sense because otherwise the resonance of a particle would overflow the Planck length. The resonator of unit length imagined to get the mass formula is simply a Planck particle defining a unitary box.
- The wave h_{15} and the coupling h_{16} only use numbers known through the mass spectrum and h_6.
- The Higgs field as it appears at h_{28} requires no other particles.
- The second sector involves interactions directed by dimensions and there then by symmetries; this is more than enough to encompass the symmetries of the standard model but also imply a form of selection by the fact that all the second sector must work together – a form of filtering.

We understand that space-time, particle resonances, and couplings are of gravitational and electromagnetic origin and that there is no freedom in the structure of the particle spectrum. The resulting laws and parameters form a coherent, compact, inseparable, and non-adjustable block.

7 Wave-coherent cosmology

An expanding universe where the laws of physics are everywhere identical and whose parameters are consistent with the preceding sections is necessarily a single resonance with a localized origin; if considered homogeneous its macroscopic quantities cannot have any degree of freedom. All must therefore be calculated from its geometry; hence from its age alone or from its horizon.

7.1 Black holes

The calculation of the Planck mass from an oscillator made of pure numbers poses a real problem, because the oscillator alone must define space-time; hence the metric by which it scales the particle resonances; therefore the Planck length varies in space and time. Consequently for a Schwarzschild black hole of mass M, the radius

$$R_S = \frac{2\,G\,M}{c^2}\,, \tag{97}$$

can only be a wave number. We naturally think of

$$R_S = n\,l_p \pm l_p\,, \tag{98}$$

with n an integer and $\pm l_p$ an uncertainty. But its characteristics are entirely defined by a real factor E defined by $M = E\,M_\omega$ and verify:

$$R_S \equiv M = E\,M_\omega = E\,X_e\left(\frac{D_e}{266^2} + D_p^4\right)^{-3}\,, \tag{99}$$

and its average mass density ρ_S reported inside the sphere of radius R_S verifies:

$$R_S \equiv M = \frac{4\,\pi}{3}\,\rho_s\,R_S^3 \rightarrow \rho_s \sim R_S^{-2}\,. \tag{100}$$

Then we identify the squares and the cubes in this relation

$$M = E M_\omega = \rho_S R_S^3 = \frac{E^3}{E^2} M_\omega$$
$$\to \rho_s \equiv \frac{X_e}{E^2} \;\; ; \;\; R_S \equiv E\left(\frac{D_e}{266^2} + D_p^4\right)^{-1} . \qquad (101)$$

This expression shows the gravitational nature and structure of the mass formulas, and that the Schwarzschild radius of the Planck mass, say R_ω, can be considered as a unit wavelength because in natural units

$$R_\omega = 4\pi\, l_p \equiv 4\pi\left(\frac{D_e}{266^2} + D_p^4\right)^{-1} . \qquad (102)$$

We then recognize the Hawking temperature which, even if in principle external, can only be the effect of the harmonic system:

$$K_B\, T_H = \frac{\hbar\, c^3}{8\pi\, G\, M} = M_\omega\, c^2\, \frac{M_\omega}{M} = \frac{M_\omega\, c^2}{E} , \qquad (103)$$

where we recover the scale factor E of the expression (99). And M_ω is a resonance; this relation identifies this temperature to its wavelength; giving a GR – MQ symmetry where l_p, λ and R_S evolve together in the gravitational field for a particle at rest seen by a distant observer, and not the other way round for the last two. Likewise it comes

$$K_B\, T_H = \frac{\hbar\, c^3}{8\pi\, G\, M} = \frac{h\, \nu_\omega}{E} , \qquad (104)$$

where $\nu_\omega = M_\omega\, c^2/h$ is a frequency, and ν_ω/E is that of the black hole. The wavelength of a black hole then varies like its mass and its radius, and its frequency conversely. Now the similarity with the equation of an ideal gas $P\, V = K_B\, T$ already discussed after the formula (2) is obvious. In the case of a black hole, P represents a surface pressure, but in the case of an ideal gas the internal pressure is constant, which perfectly fits the scale factor E. However, according to (101) we can identify a wave internal to the black hole whose dispersion at $r > R_S$ defines the metric. This wave is then the effective Planck length at the place considered, the maximum resolution decreases near the black hole down to R_S at its surface; we note the absence of singularity.

With the connections between the couplings and the two sums Σ_{NP} and Σ_K, we have linked gravity (as a force) to resonances and couplings through relative variations of the Planck length, therefore of the relative resolution. Consequently, the harmonic h_8 expressing a constraint in the form of a four-dimensional sphere surface coefficient ($2\pi^2$) associated with a phase variance ($1/\pi$) and dominating the spectrum of resonances, the universe is studied as the surface of a resonant 4-sphere which expands into a four-dimensional exterior. We consider a homogeneous universe where the celerity c is constant and where, due to homogeneity, the effective Planck length l_p varies only in time and defines a homogeneous metric in 3-space at any time. Obviously we forbid ourselves to add particles or fields, but suppose a single field or space undergoing a transformation. In this way the past is static, the future dynamic, and the present a phase transition.

7.2 Universe mini-model

Expanding into an exterior, the universe is modeled by a solid expanding 4-sphere centered on its origin of which 3D space (the present) is the surface. We therefore assume that the particles are growing strings, and that the interior of the sphere is fixed in the sense of the events – not in the sense of the phases of the resonances, but in the sense of the derivatives of the phase variations of the wave at any point.

In a perfectly homogeneous universe the cosmic time T is the meaningful physical quantity; in wave number $n = T/t_p$ is the number of "Planck sheets" or layers constituting the past. Taking the original event at $n = 1$, its resonance length L_1, then for $n >> 1$ the sum of the inverses of the resonance lengths is

$$\frac{1}{L(n)} = \frac{1}{L_1} \sum_{i=1}^{n} \frac{1}{i} = \frac{1}{L_1} \left(\ln(n) + \gamma\right) , \qquad (105)$$

with γ the Euler-Mascheroni constant. This formulation corresponds to the fact that in an expanding universe the surface of the layer n depends on n^3, which complies with the mass formulas; this expression means that the present "feeds" the past and that a source energy is consumed (actually of unit J m $\sim h\, c$). The sphere is divided into layers, the weight of each is its layer number, and we sum the inverses according to the rule. The energy of the layer n then evolves like

$$E(n) = E(1)\ (\ln(n) + \gamma) = E(1)\ \ln(k\, n) . \qquad (106)$$

Massive particles are harmonics of the Planck mass; it is then necessary to count in Planck time to obtain a universal clock, since it is the natural one and the logarithm implies that the numerical results depend on the clock we choose. In the absence of creation of matter, the Compton wavelength of a particle is therefore

$$\lambda(n) = \frac{\lambda(1)}{\ln(k\, n)} . \qquad (107)$$

This mechanism and this formula apply to any particle and therefore to the Planck length. This relation amounts to writing $\Delta E\, \Delta t = 1$ for any string between any two layers with a naturally oriented time; that is one quantum of action exchanges between any two layers of any string; actually not action h but $h\, c$, which in 4D is to energy what energy is to power in 3D.

Now if masses add up, charges multiply; then from the same logic as for the evolution of wavelengths, we obtain a charge formula for a given epoch

$$C = \sum_{i=1}^{n} \frac{1}{n!} = \exp(1) . \qquad (108)$$

For the observable universe $n > 10^{55}$, we can therefore write an equality. The base of the natural logarithm also intervenes in the coupling D_{μ_e} (20) with Sommerfeld's constant in the form $\exp(1) \times \alpha$; a logarithm is also present in the same formula; these component denote temporal resonances.

The expression (107) defining the wavelengths evolution is all we need to discuss cosmology. The rest of this section contains only solutions to outstanding tensions and mysteries which, as far as we know, cosmological models do not relate to each other; all derived from the geometry of this mini-model and this expression.

7.3 The Hubble parameter

The immediate application concerns the Hubble parameter which is a function of time $H(n)$. We have on the one hand the expansion of the 4D sphere, therefore of 3D space at its surface, which depends only on proper time. The associated scale factor is therefore for a homogeneous spherical universe, still using the Planck time and lengths as units

$$a_e(n) = n\,. \tag{109}$$

The expansion implies a second scale factor coming from the contraction of wavelengths (107),

$$a_m(n) = \ln(k\,n)\,, \tag{110}$$

which corresponds to a contraction of rulers. Their product gives the transformation of measurable space-time intervals

$$a_{it}(n) = a_e(n)\,a_m(n) = n\,\ln(k\,n)\,. \tag{111}$$

In the laboratory the space intervals defining the measurement rods evolve over time

$$a_l(n) = \frac{1}{a_m(n)} = \frac{1}{\ln(k\,n)}\,. \tag{112}$$

The cosmic microwave background by which the Hubble parameter H_{cmb} is measured was emitted at

$$\mathrm{T_{cmb}} = 380\,000\,\text{years} \rightarrow \mathrm{p} = \frac{\mathrm{T_{cmb}}}{\mathrm{t_p}} = 8.87 \times 10^{55}\,,$$

a unitless wave number; and we now are at

$$\mathrm{T} = 13.801\,\mathrm{Gy} \rightarrow \mathrm{n} = \frac{\mathrm{T}}{\mathrm{t_p}} = 3.22 \times 10^{60}\,,$$

and according to (112) the contraction of ruler between these two epochs is

$$\frac{\ln(p)}{\ln(n)} \approx \frac{1}{1.082}\,. \tag{113}$$

The photon is a string like any other, its wavelength evolves exactly like that of massive particles. So the Hubble parameter H_{cmb} measured through the frequency shift of the fossil radiation depends only on a_e, the scale factor due to recession. At the opposite, the local Hubble parameter H_{loc} is measured from supernovae luminosity, so 1) as a time interval, since this signal has a duration, and 2) as a solid angle which depends on the telescope and the expansion. Nothing new on the principle, but the measurement of the signal duration depends on a_{it}, and its instantaneous power of the solid angle of capture of the signal, that is $a_l^2/a_e^2 = a_{it}^{-2}$ because space has expanded between emission and reception, and simultaneously the lengths defining the telescope have contracted. The instantaneous luminosity therefore depends on a_{it}^{-3} and the total luminosity measured on a_{it}^{-2}; the measured recession is therefore a_{it}. In the end, therefore, we have the following dependence between the two methods of measurement

$$H_{loc} = H_{cmb}\,\frac{\ln(n)}{\ln(p)} = H_{cmb} \times 1.082\,. \tag{114}$$

Estimates using standard candles methods [14] concentrate around $H_{loc} = 73\,\mathrm{km/s/Mpc}$, and the Planck mission indicates [13] $H_{cmb} = 67.66\,(42)\,\mathrm{km/s/Mpc}$. The relation (114) gives

$$67.66\,(42) \times 1.082 = 73.17\,(45)\,.$$

Here the associated tensions are natural and explained. The precision may seem very good, but this is not so because the logarithm attenuates the errors on n; if we multiply n by 2 we obtain 1.083, by 10 we get 1.10, not much but we clearly see this ratio increasing over time. Consequently, the universe is permanently building resolution.

The ΛCDM model interprets these measurements as an accelerated expansion because a cosmological constant is the natural solution in GR. Then, deriving (110) to (112) and using the cosmological radius $R_U = c\,T$, it comes

$$\ddot{a}_m = (\dot{a}_m)^2 = \frac{1}{a_e^2} = \frac{1}{n^2} \rightarrow \frac{1}{R_U^2} \approx 0.6 \times 10^{-52}\,\mathrm{m}^{-2}\,, \tag{115}$$

which is close to the estimated value of the cosmological constant (to within a factor of the order of 2).

Let us now return to the Planck clock and the rulers contraction between two epochs. With another clock such that $n \rightarrow n/q$ and $q > 1$, it comes

$$\frac{\ln(n)}{\ln(p)} \rightarrow \frac{\ln(n) - \ln(q)}{\ln(p) - \ln(q)} = \frac{\log_q(n) - 1}{\log_q(p) - 1}\,, \tag{116}$$

which amounts to changing the constant of integration. It is only when the constant is zero that the universe has unit size at the origin. We can also see there a change of base of the logarithm and the introduction of a negative constant of integration showing that the length of the ruler is in excess, then irrelevant, and that the beginning physically compares only to the Planck time. We can also write

$$\frac{a_m(n)}{a_m(q)} = \frac{\ln(n)}{\ln(q)} = \log_q(n) = \log_q\left(\frac{n}{q}\right) + 1\,, \tag{117}$$

which clearly indicates the choice of time unit and allows us to change it, on the condition of knowing the absolute date.

7.4 Dark energies and energy

The object of this section is to study the correspondence with the ΛCDM model through the respective proportions of its four main parameters, namely the proportions of ordinary matter, dark matter, dark energy, and the total density. We do not yet look for absolute quantities, only to understand how these parameters relate to each other in relative terms.

Consider a uniform positive pressure P *in the surface of nonzero thickness* of a four-dimensional Euclidean sphere of radius R. The condensation of a new layer corresponds to an absorption producing the growth of the strings and a pressure deficit which, seen by an observer *in the surface of the sphere* using GR to model cosmology, will guess a constant negative pressure. This negative pressure is understood here as a condensation density simultaneously generating the particles' energy and gravity. The source energy M_S invested in the condensation must then be separated into three parts, namely 1) the visible energy, 2) a remainder of force without visible source (dark mass) because the wavelengths vary from one time to another, and 3) a dark energy of negative pressure causing the expansion of the sphere. Condensation can be modeled in 3+1D as a kinetic energy $M_S = p\,c$; but here it is the transformation $X_e \leftrightarrow X_\alpha$ which is equivalent to a bounce and implies $M_S = 2\,p\,c$. The dark energy of the standard model therefore represents $2/3$ of all (2 for the source energy and 1 for the masses). Quantitatively, the condensation occurs with h_8 which implies proportions 1 for ordinary matter and $2\pi^2$ for source energy (1 is the time axis, $2\pi^2$ the surface of the sphere); so for convenience let us define

$$\phi = \frac{1}{2\pi^2}\,. \tag{118}$$

The ΛCDM model considers ordinary matter separated from the dark side, its proportion of mass is therefore given by

$$\frac{M_V}{\phi} = \frac{M_S}{1+\frac{2\phi}{3}} \rightarrow \frac{M_V}{M_S} = 4.90\,\%\,. \tag{119}$$

The mass of matter will be one-third the source energy, but is separated into ordinary and dark matter; the proportion of the latter is therefore

$$\frac{M_D}{M_S} = \frac{1}{3\times(1+\phi)} - \frac{M_V}{M_S} = 26.83\,\%\,, \tag{120}$$

and dark energy is the remainder

$$M_{DE} = M_S - M_D - M_V \rightarrow \frac{M_{DE}}{M_S} = 68.27\,\%\,. \tag{121}$$

Finally:

1. These proportions are invariant over time.
2. They agree perfectly with the Planck mission results [13]: $M_B = 4.9\,\%$, $M_D = 26.8\,\%$, and $M_{DE} = 68.3\,\%$.
3. The absorption density is the saturation point known from the mass M_ω, imposed by the mechanism: The entire source energy intervenes there through the division by ϕ giving a surface density on the 4-sphere.

On this basis we can complement the calculation of the cosmological constant. Using $\ddot{a}_m$ (115), the expansion factor of space is that of a 3-sphere in GR, $4\pi/3$, and there is the factor $1/2$ from $M_S = 2\,pc$ to take into account. Then using the Hubble factor

$$\Lambda = \frac{2\,\pi\,H_{cmb}^2}{3\,c^2} = 1.121\times10^{-52}\,\mathrm{m}^{-2}\,, \tag{122}$$

in good agreement with the Planck mission results (to 1.3%).

$$\Lambda_{Planck} = 1.106\times10^{-52}\,\mathrm{m}^{-2}\,. \tag{123}$$

The current value, using $H_{loc} = 73.17$ km/s/Mpc gives

$$\Lambda_{loc} = \frac{2\,\pi\,H_{loc}^2}{3\,c^2} = 1.31\times10^{-52}\,\mathrm{m}^{-2}\,. \tag{124}$$

Last, using the cosmological radius $R_U = c\,T$, which is the legitimate way in this mini-model

$$\Lambda_{R_U} = \frac{2\,\pi}{3\,R_U^2} = 1.23\times10^{-52}\,\mathrm{m}^{-2}\,, \tag{125}$$

logically a median value.

7.5 The cosmological constant

The method used here to model the impact of $a_e\,a_m$ is to reverse their roles; we model an increase of masses, insert it into the Schwarzschild solution, and modify it *à la* de Sitter; with a little more because the masses are not constant. By setting the total universe energy to $M_T = M_S$, the previous section states

$$2\,G = \frac{R_U\,c^2}{M_T}\,, \tag{126}$$

where $R_U = c\,T$ is the cosmological radius at date T and M_T the total energy of the ΛCDM at T, which symmetries the Schwarzschild solution

$$\frac{R_s}{r} = \frac{R_U\,M}{M_T\,r}\,. \tag{127}$$

This equation simply indicates that Newton's constant conforms to a condensation whose saturation point is the density of a mass $E\,M_\omega$ on the observable scale. It is legitimate with R_U (and the following calculations can only work) because the proportions of matter and dark energy are constant over time, and the resonance is temporal. We therefore perform the calculations as if the universe was a plane, of size R_U, and of constant densities. To continue, it is necessary to add variable terms that depend on r/R_U, which requires two parameters α, β,

$$\frac{R_s}{r} = \frac{R_U\,M}{M_T\,r} \rightarrow \frac{R_U\,M}{M_T\,r}\times\frac{R_U-\alpha\,r}{R_U+\beta\,r}\,. \tag{128}$$

The term in α in the numerator corresponds to the expansion of the source energy like R_U, and the term in β in the denominator to the derivative of the masses expansion. The two terms are obtained by adding lengths because we are talking about the inverse of the gradient of L_p in space and the inverse of its derivative in time, which also inverts the signs. A series expansion to the second order gives

$$\frac{R_U\,M}{M_T\,r} \to \frac{R_U\,M}{M_T\,r} - \left(\alpha+\beta\right)\frac{M}{M_T} + \beta\left(\alpha+\beta\right)\frac{M\,r}{M_T\,R_U}. \tag{129}$$

Let us examine this expression:

- The first term is nominal and defines static space, fields, and masses; the others can then be considered as addition of a variable gravity field.
- The middle term is independent of r and therefore involves the total mass of the universe; M must then be integrated to M_V, and the total must give -1 the flat metric. Then we have $\alpha+\beta = 2\pi^2+1$.
- So the term on the right must also be integrated into M_V to give M_T (and becomes r/R_U); therefore $\beta = 1$ the visible masses and $\alpha = 2\pi^2$ the source energy.

Note that with a series expansion in r we cannot integrate to R_U, but we can do it to M_V as the central term requires. In the end, after replacements and integration to M_V we find

$$\frac{R_s}{r} = \frac{R_U\,M}{M_T\,r} \to \frac{2\,G\,M}{r\,c^2} - 1 + \frac{r}{R_U}. \tag{130}$$

The Schwarzshild-de Sitter solution has a similar formulation

$$-\frac{R_s}{r} \to -\frac{R_s}{r} - \frac{\Lambda\,r^2}{3}\,. \tag{131}$$

Adding a variable term then gives

$$-\frac{R_s}{r} - \Lambda\,r^2 \to -\frac{R_s}{r} - \Lambda\,r^2 - \delta\Lambda\,r^2\,, \tag{132}$$

which is identified term to term with (130), and where the factor 1/3 of (131) is removed because it comes by integration to give $\Lambda\,r^2/3$, and here it is $\delta\Lambda\,r^2$ which must be integrated. The introduction of a geometrical constant k allows to solve the equation as it must give (130):

$$-k\,\Lambda\,r^2 - \delta\Lambda\,r^2 \to -1 + \frac{r}{R_U}\,. \tag{133}$$

Since Λ is now constant, integration to R_U is possible and gives the flat metric identified in the unit term of (130); hence:

$$-k\,\Lambda\int_0^{R_U} r^2 dr = -1 \to k\,\Lambda = -\frac{3}{R_U^3}\,. \tag{134}$$

Now we need to derive $k\,\Lambda$, but here masses increase and Λ constant, and $\delta\Lambda$ represents the inverse of the masses derivative; so we need to derive the inverse to get $\delta\Lambda$; for all r we set $R_U \to r$, and since k is a geometrical factor we remove it

$$\delta(\Lambda(r)) = \left(\frac{d}{dr}\left(\frac{r^3}{3}\right)dr\right)^{-1} \to -\delta(\Lambda(r)) = -\frac{1}{r^2}\,, \tag{135}$$

and put it back to cancel the integration factor over the solid angle; then multiply by $1/2$ and identify with $-r/R_U$ we get

$$\frac{4\pi\,k}{2}\int -\delta(\Lambda(r))\,r^2\,dr = \int -2\pi\,k\,dr = -\frac{r}{R_U}\,. \tag{136}$$

Therefore

$$k = \frac{1}{2\,\pi\,R_U}\,. \tag{137}$$

Last, report in (134)

$$\Lambda = \frac{2\,\pi}{3\,R_U^2}\,, \tag{138}$$

as expected we get (125). The Schwarzschild and de Sitter solutions as modified here amount to differential equations that we integrate; it corresponds to the mini-model but contradict GR, but recall Einstein designed this theory with a static universe in mind – proof is his famous mistake to stabilize it. This is why in this mini-model space and time are not on strict equal grounds. Moreover, because of integration to M_V made after (129) the results are independent of the creation of particles at any time.

7.6 Anomalous accelerations, MOND

The standard model of cosmology evaluates the parameters necessary for its operation; but here the absence of dark matter particles makes it incompatible with the phenomenology of gravitation. However, in the absence of dark matter particles we can use the mini-model to recover MOND [11], [12].

The radius of the universe 4-sphere being n its circumference is $2\,\pi\,n$; and from (110) an observer will see the expansion accelerating. The instantaneous acceleration A of the expansion will depend on

$$\dot{a}_m = \frac{1}{n} \to A = \frac{1}{2\,\pi\,R_U}\ \mathrm{m}^{-1}\,, \tag{139}$$

which, as we expect, is the k factor in (137). A remote object recession will be seen accelerating:

$$\frac{d^2r}{dt^2} = A\,c^2 \to a = \frac{c^2}{2\,\pi\,R_U} = 1.185\times10^{-10}\,\mathrm{m\,s^{-2}}\,, \tag{140}$$

which, according to Milgrom is MOND limit acceleration $1.20\,(\pm0.2)\times10^{-10}\,\mathrm{m\,s^{-2}}$ [11] [12]. Another direct way to this result is to understand the effect of the evolution of the electron Compton wavelength on the Bohr radius; it shrinks when the wavelength decreases

$$a_0 = \frac{\lambda_{dB}}{2\,\pi} = \frac{\lambda}{2\,\pi\,\alpha}\,, \tag{141}$$

where the factor $2\,\pi$ is consistent with (140) and implies that, unlike energy, angular momentum is absolute and conserved; in agreement with QM and with the interpretation of $\Delta E\Delta t$ in (106). Now we can discuss the central mass problem in which the expansion of the central mass adds a term to the classical potential, making it increase in time. Therefore a simple sum of a and the Newtonian acceleration A_N giving $A_N + a$ is unacceptable, as the so-called anomalous accelerations are free fall in an evolving gravity pit. We therefore return to the weak equivalence principle, according to which an acceleration is indistinguishable from gravity; the opposite case makes it possible to reason by symmetry on the acceleration formula. A force f on an object of mass m in free fall with a Newtonian acceleration A_N giving an effective acceleration A_{eff} is felt as $A_r > 0$:

$$A_N \left(1 + \frac{A_r}{A_N}\right) = A_{eff} \rightarrow A_r = \frac{f}{m}\,, \qquad (142)$$

here the acceleration felt, $A_r = f/m$, is the effect of inertia and we are looking for the effect of an increase in gravity. So to link the effective acceleration A_{eff} and the two quantities A_N and a in a classical form we need to write the transformation inverse to (142); an inversion of the roles which amounts to calculating A_N. Firstly we rewrite (142):

$$A_N = A_{eff} \left(1 + \frac{A_r}{A_N}\right)^{-1} \rightarrow A_r = \frac{f}{m}\,,$$

Secondly, we use the fact that Newton's acceleration A_N have no physical reality; on the right-hand side we replace it with the real one, and the acceleration felt by the unfelt:

$$A_{eff} \left(1 + \frac{a}{A_{eff}}\right)^{-1} = A_N \rightarrow A_r = 0\,. \qquad (143)$$

This expression is MOND simple interpolation function, one of three possible [12]. We can also derive the same formula from the harmonic system in a direct and elegant manner that treat space and time on natural non-equal grounds: A_{eff} depends on the gradient of the effective Planck length, which has two components, 1) its instantaneous gradient in space, and 2) its variation in time. The former gives the classical acceleration A_N, which can be approximated by subtracting the effect of the latter from the total. Then by adding the inverses, we subtract from the effective gradient of resonance length (total gradient with A_{eff}) its variation over time in proportion of the gradient (a/A_{eff}) at the considered location to get A_N, i.e.

$$\frac{1}{A_N} = \frac{1}{A_{eff}} \left(1 + \frac{a}{A_{eff}}\right) \rightarrow A_r = 0\,, \qquad (144)$$

which is identical to (143). We use again the same formula for length addition, now applied to the variations of resolution in space and in time. The evolution of a is immediate as it depends on $1/T$ and decreases with time; this acceleration is therefore a lot stronger in the early universe than at present time, up to $a \rightarrow \infty$ when $T \rightarrow 0$.

7.7 Comments

To begin this section, we applied the length addition formula used for masses to the entire universe, simply our initial hypothesis, to obtain a temporal resonance formula (106) based on a logarithm which complies with the mass formulas. Then, by extending the logic to charges, we found an exponential (107); both are in the calculation of the μ_e mass (21) and in the relation (67) between X_e and X_α, and only there, showing a scaling effect.

On this basis we deduced the Hubble factor correction, the four densities, the cosmological constant, the limit acceleration and interpolation formula of MOND; we obtained eight coherent quantities from the age of the universe alone, which is not possible with the models and theories that use them.

We remark that the expansion of space a_e (109) and energies a_m (110) can be inverted, resulting in a logarithmic expansion of space and a linear expansion of energy (as we did in section 7.5); the resulting model gives the same results provided that the unitary resonances of neutrinos and photons have specific properties. We discussed the simplest scheme where the dimension that we call time expands linearly in 4-space.

8 Questions and extensions

8.1 Dimensions and resonances

The whole sequence h_i seems to include a triple cycle, 4 to 4, 7 to 7, and 8 to 8. The dimensional coefficients from h_8 to h_{11} rise from 4 to 7; the objects present for h_{13} are the 3D and 5D sphere volumes, and for h_{14} two sphere surfaces in 6D and 3D. Then we apparently have a limit with 8D. Since the super-coupling h_{16} can be decomposed into two, we also assume that it is in 4+4=8D. Consequently, D_p and D_e are dimensional couplings and the first sector range from 1 to 7 dimensions. Since particle resonances are radial or rotations, a single 4D space is sufficient for resonances to build a 7 or 8D structure: We assume for the discussion that a 4D space is native and, from the sequences h_i and c_i, that space-time is built by the interplay of resonances. The first sector and the particle resonances K are then explained by Table 7; the particle spectrum is defined by the dimension of each resonance.

- Sign = the resonance has an echo of same dimension.
- Sign + the dimensions add.
- Sign ≠ distinct resonances in the two spaces.

We find the following concordances

- The larger the resonance dimension, the larger the mass and the stronger the coupling strongest component.
- Tables 1 and 2 use the same K for the electron and muon, simply the dimension of their resonances.

Table 7: Resonances and dimensions.

-	Particle	Dim	4D	$\leftrightarrow$	3+1D	Tbl
h_0	M_ω	0/8	0/4	=	0/3+1	(43)
h_1	ν	1	1	=	1	6
h_2	e	2	1	+	1	1, 2
h_2	q (P)	2	1	+	1	3
h_3	μ	3	3	=	3	1, 2
h_4	τ	4	4	$\neq$	3+1	1, 2
h_5	q (N)	5	4	+	1	3
h_6	g	6	3	+	3	-
h_7	W, Z, H, γ	7	3	+	3+1	5

- The tauon is exceptional in that it admits two unequal solutions, two distinct ways of oscillating in 3+1 and 4 dimensions.
- The rotational part N of quarks mix, this is clear for the u and d, and not P the radial part, but $P = 3$ constant pose no problem to mixing.
- We understand that the left-hand side of the relation (14) giving the small k of the boson resonance, which seems a bit strange in 3 dimensions, corresponds to 3+(3+1) dimensions with a resonance of a 6-sphere as seen in 3; by introducing a factor $k\pi$ in the denominator of the mass formula (11) the volume of the 6-sphere becomes

$$\pi^3 r^6 \to \pi^3 (k\,r)^6 \to \pi^2\,(k\,r)^6\,, \tag{145}$$

then taking the square root to return to 3 dimensions we obtain the term on the left of (14)

$$\pi^2 (k\,r)^6 \to \pi\,(k\,r)^3\,, \tag{146}$$

with $r = 1$ and $\pi \to \pi/144$, since this part is circular. And on the right-hand side, we calculate a radial impact as the compression of a 1 dimension line by stress or forces in 3 dimensions, i.e. with an inverse effect between forces and lengths:

$$\frac{\pi\,r^3}{k} \to \left(\frac{\pi}{k}\right)^{1/3} r\,, \tag{147}$$

now with $r = 266\,D_b$. Since r is a wave number or its inverse, we introduce it as the two sides of the resonance and obtain (14).

Resonances organize well by counting only 1, 3 or 4 dimensions, and all bosons use at least 3+3 dimensions. Logically, the photon is in h_7 and neutrinos in h_1; leptonic resonances from h_1 to h_4, and bosonic resonances from h_5 to h_7. Quarks are supposed to mix; they take one component of each side with $P = 3$ in h_2 and one of the rotations of h_5 for N.

The electrons and quarks K are given here by the dimension, provided that time counts for 2D in space-time:

- The electron resonance in h_2 is in 2 dimensions of time.
- The muon h_3, 3 dimensions of space.
- The tau h_4, 4 dimensions in native space and $K = 4$ Table 2, and 3+1 in space-time where time counts double then $K = 3 + 2 = 5$ Table 1.
- Heavy quarks ring in 2 dimensions h_2, and 5 dimensions h_5, but time must be accounted for only once then subtract 5D from 2D to get $K = 2 \times (2 - 5) = -6$.
- Light quarks ring in 2 dimensions h_2, but N uses two rotations and time may be accounted for differently, then possibly:
  - d remove one, 4D and $K = 2 \times (2 + (1 - 5)) = -4$;
  - u multiply by 2 for charge 2/3 versus 1/3 for the d.

8.2 Super-minimal super-strings?

In the universe mini-model the present feeds the past, which means that downtime currents feed the strings, providing the necessary "power" for both downtime and uptime currents. There should be a dissymmetry in strength between up-time and down-time in a ratio 1 to 2. Downtime currents twice as strong as the uptime will give double charges; i.e. 2/3 and 1/3 and impact the resonance by a factor of 2 like in Table 3, the electron charge being the fusion of the two. The explanation for the existence of 3 elementary electric charges is very basic and can correspond to a quantitative law of transformation. In the two series h_i and c_i resonances and couplings appear separately, like in the mass formulas, and the couplings do mirror resonances. Overall, three different manners to observe the same mirror where $1/N\,P > K\,D$ for all resonances where $N\,P > 1$ which can mean a form of super-strings – except for M_ω where the resonance can be seen inverted since $D_p^4 < D_e/266^2$. Then we associate the apparent electric charge of a particle with the direction of a current independently of the resonance. On this basis we need four rules to complete the elementary particles' charges contents which we denote with arrow and sign:

1. The signs correspond by convention to the current, the measurable electric charge reverses for downtime currents (like electricity going backward in time).
2. Two currents of opposite charge can combine to form a single string, or a (sub)string within a string.
3. Two currents of the same charge cannot.
4. Currents can make massive particles, then vertical arrows propagating in time like a massive particle; or mass-less, then propagating on the light cone, oblique arrows (neutrinos and photons).

Table 8 shows all particle types regardless of their resonance. The parentheses represent sub-strings association, and brackets a particle contents.

The mass μ_e is the proper mass of $[+\uparrow, -\downarrow]$, which can fall into the three electron resonances (h_2, h_3, h_4), as can

Table 8: Minimal scheme for currents symmetry.

Charge	Particle	Spin	Currents
0	ν	1/2	$[(-\swarrow\ +\swarrow)(-\nearrow\ +\nearrow)]$
+1	μ_e/μ_α	1/2	$[(+\uparrow\ -\downharpoonleft)]$
−2/3	u, c, t	1/2	$[(+\downharpoonleft)]$
+1/3	d, s, b	1/2	$[(+\upharpoonright)]$
+1	W^+	1	$[(+\upharpoonright)(-\downharpoonleft)]$
0	Z^0	1	$[(-\downarrow\ +\downharpoonleft)(-\uparrow\ +\upharpoonright)]$
0	H^0	0 or 2	$[(-\upharpoonright)(+\downharpoonleft)(+\upharpoonright)(-\downharpoonleft)]$
0	γ	1	$[(-\nearrow\ +\swarrow)(-\swarrow\ +\nearrow)]$

quarks with $[\pm\uparrow]$ and $[\pm\downarrow]$ and h_5, and the four bosons with h_{28}. The distinctions between $W^\pm$, H^0 and Z^0 are consistent with the calculation of their masses and widths. The spins agree with 1/2 for any inner string (the most inner parenthesis for each scheme). In the end, there is only one type of current, oriented only in charge and with respect to time; all assemblies are symmetrical except for quarks, which are confined. We're missing the gluons, which should correspond to eight separate horizontal arrows, with the ubiquitous quality of also manifesting like a monopole. Now let us draw a few examples of transmutations, to begin with $d^+ \rightarrow u^- + W^+$

$$[(\underline{+\upharpoonright})] \rightarrow [(+\downharpoonleft)] + [(-\downharpoonleft)(\underline{+\upharpoonright})]\,. \tag{148}$$

The d^+ current is conserved and passes into the W^+, what remains (i.e. the $(+\downharpoonleft)$ and $(-\downharpoonleft)$ not underlined) does not exist as a particle; if this is a systematic rule it prohibits FCNC because in the following case the remainder is also a Z^0 which is an existing particle, $s^+ \rightarrow d^+ + Z^0$

$$[(\underline{+\upharpoonright})] \rightarrow [(+\upharpoonright)] + [(-\downarrow\ +\downharpoonleft)(-\uparrow\ \underline{+\upharpoonright})]\,. \tag{149}$$

The muon case, $\mu^- \rightarrow W^- + \nu_\mu$:

$$[(-\uparrow\ +\downharpoonleft)] \rightarrow [(-\upharpoonright)(+\downharpoonleft)] + [(-\swarrow\ +\swarrow)(-\nearrow\ +\nearrow)]\,, \tag{150}$$

next is its symmetric, $W^- + \overline{\nu_e} \rightarrow e^-$:

$$[(-\upharpoonright)(+\downharpoonleft)] + [(-\swarrow\ +\swarrow)(-\nearrow\ +\nearrow)] \rightarrow [-\uparrow\ +\downharpoonleft]\,. \tag{151}$$

This is because neutrino and anti-neutrino are identical. Two up-time or down-time arrows for neutrinos and Z^0 can also be removed for the same results; the choice made here is that every up-time current is associated with a downtime current, and conversely – except for quarks, where currents have the same sign and the association of particles/strings is made by confinement.

The γ and Z^0 cases are the simplest, as we obtain (for example) the following two reversible cases. For $e^+ + e^- \rightarrow Z^0$:

$$[(+\uparrow\ -\downharpoonleft)] + [(-\uparrow\ +\downharpoonleft)] \rightarrow [(-\downarrow\ +\downharpoonleft)(-\uparrow\ +\upharpoonright)] \tag{152}$$

and for a photon, $e^+ + e^- \rightarrow \gamma$:

$$[(+\uparrow\ -\downharpoonleft)] + [(-\uparrow\ +\downharpoonleft)] \rightarrow [(-\nearrow\ +\swarrow)(-\swarrow\ +\nearrow)]\,. \tag{153}$$

A minimal form of (super) symmetry is evident, where each lepton charge (μ_e mass or neutrino) is associated with a boson of same charge. Since we find 8 resonances for quarks in h_5 (49) and c_3 (92), including twice two indistinguishable masses for u and d, we're all set with 8 gluons in h_6. It is the μ_e mass and h_6, together with the separation of resonances and couplings in the sequences h_i and c_i that makes this minimal scheme possible as the resonances (N, P) do not define charges and spin, the couplings and inner currents do.

8.3 Transmutation and resonance

At the general level, the $N = P = 19 - 7$ of bosons includes all circular resonances (7 and 19), enabling transmutations of N or P of electrons and quarks; the product of their $K = 266$ includes all primary field resonances. In transmutations, this allows exchanges of resonances by sums and products:

- by product, with the $K = -2$ of the $W^\pm$ for the N of quarks within the second or third generation.
- for u and d quarks, by product with the $K = -2$ of the $W^\pm$ for the K, and cross exchanges of 14 and 19 for N.
- by sum $\pm 12 = 19 - 7$ associated with a product exchange by the $K = -2$ of the $W^\pm$ between the second and third generation of quarks.
- by mixed exchanges of the previous ones when the first and another generation is involved.
- FCNC would imply a product exchange in N which is not the K of a neutral boson.
- by sum or subtraction of the $K = -7$ of the Z^0 for the N and P of the electrons.
- The resonances of neutrinos (K) are an inverted echo of the resonances N, P of the corresponding electron, there is a form of conservation in these transmutations to which the Z^0 and the $W^\pm$ are neutral.
- All particles couple in N, P, sometimes separated, with D_p^i through its 137 and $-19\pi^2$, which is the $K = -19$ of the H^0, coupling in mass in the Standard Model.

Recall also that the total resonance widths of the three bosons were calculated in section 2.4. Hence the resonances speak directly of transmutations; the form of which obeys, and then implements, some conservation of the resonances geometry.

8.4 And the strong force coupling?

According to Table 8, quarks should be the expression of the most fundamental components of massive particles, and then also the quark mass coupling D_q, which we compare to that of electrons to get a ratio of lengths:

$$\frac{D_q}{D_e} = 1 + \alpha\,, \tag{154}$$

and specifically for the full coupling $K\,D$ of the electron itself compared to that of a heavy quark

$$\frac{-6\,D_q}{2\,D_e} = -3 - 3\,\alpha\,. \tag{155}$$

Now recall that in Table 3 the charge ratio of 1/3 to 2/3 corresponds to a resonance ratio ($N \to 2\,N$ for the second and third generation, and $K \to 2\,K$ for the d and u), hence we find again the signature of a monopole with α, including the ratio of charge 1 to 1/3. But according to h_6 (50) and h_{16} (60), it is the gluon that rings in 69.5 and it does "make" the coupling α for the mass μ_e, and the ratio μ_α/μ_e. So, consider D_e the most fundamental mass coupling and compare

$$\frac{D_e}{\alpha} = 0.1169 \tag{156}$$

and, since $139 = \Sigma_{N,P} + 2$ includes the photon and neutrino unitary resonances corresponds to the entire particles field:

$$139\,D_e = 0.1186\,, \tag{157}$$

to the range of values of $\alpha_S(M_Z^2)$ reported in the literature

$$0.117 \leq \alpha_S(M_Z^2) \leq 0.119\,. \tag{158}$$

8.5 Do photons have mass?

The current limit of the photon mass is $m_\gamma < 10^{-18}$ eV (PDG 2023). Now, from the calculation of neutrinos masses and the identification of the photon resonance in h_7, we can ask whether the photon has mass. If so, we should be able to estimate its resonance; for this we apply an inversion similar to neutrinos, which was $D_e \to 1/\alpha$, this time from the components of D_{WZ} and D_H the coupling should be as a minimum

$$D_\gamma = \frac{-1}{D_e^2}\,. \tag{159}$$

The choice of K is not immediate; since $N\,P = 1$ for this resonance and not 144 we cannot make use of any phase coherence constraint. The best we can provide is a possible lower limit with $K = \pm 266$, since 266 is part of Σ_K and not used in any other particle resonance. We obtain

$$m_\gamma \geqslant \frac{m_e}{m_e - \mu_e} \times \frac{X_e}{\pi(1 \pm 266\,D_\gamma)^3} \approx 5.3 \times 10^{-23}\ \mathrm{eV/c^2}\,. \tag{160}$$

Using $K = -19$ gives $\approx 1.5 \times 10^{-19}$ eV/c^2 a likely maximum since using $K = -7$ the calculated mass exceeds the limit by a factor of 3. In this logic the last candidate would be $K = -133$ giving $\approx 4.3 \times 10^{-22}$ eV/c^2.

8.6 SM symmetries and resonances?

The standard model of particle physics is based on $U(1) \times SU(2) \times SU(3)$ with $U(1)_Y \times SU(2)_L \to U(1)_{EM}$. With respect to the three rotations in the primary field couplings formulas of α, D_e and D_p which are respectively $+1\,\pi^2$, $+7\,\pi^2$, $-19\,\pi^2$, we naively notice:

$$7 = 2^3 - 1^3\,, \tag{161}$$

and

$$19 = 3^3 - 2^3\,. \tag{162}$$

Simultaneously, except for the mass μ_e all resonances N, P of the primary field use 1, 2, 3, 7, 19, and 12 = 19-7; and the mass μ_e includes 2/7. Here we find a bijective correspondence between the symmetries of the SM and the resonances which states that 1 is an instance of $U(1)$, 2 of $SU(2)$ and 3 of $SU(3)$. This is straightforward and needs no comment; but what could it mean?

The mass formulas are based on a cube and represents stress in the form $P\,V = K_B\,T$ where only P and T can vary (except maybe for gravitation, which is of no importance here as we only discuss particles). So, except for the electron the resonance N, P systematically include a cube difference in a cube! For the three bosons we get $m \sim 144^3 = ((19-7)^2)^3$ which is a power six of the difference of two cube differences. It means a general mechanism by which symmetries resonate individually and with each other. For electrons and quarks:

- A symmetry of order N will give N^3 as say a number of "resonance points" per unit volume.
- The symmetries of order $N - 1$ will remove $(N-1)^3$ from the order N resonance.
- And $SU(3)$ includes instances of $SU(2)$ which includes instances of $U(1)$.

It means that each and every "resonance point" is a unitary resonance with unitary impact on the mass calculation.

- For the three electrons we only have 2 and 7 in the resonances meaning that $SU(3)$ is absent at this level, and may intervene only through the coupling of the mass μ_e.
- for quarks, $SU(3)$ is present giving 19 and 38; $SU(3)$ includes instances of $SU(2)$, then 7 and 14, the u and d include the four possible fractions using these numbers where from Table 3 $N = a/b > 1$.
- For the three (massive) bosons we find the same structure, this time not with respect to the symmetries but to the fermion field elementary resonances 2, 7, and 19, giving $12 = 19 - 7$ and $266 = 2 \times 7 \times 19$.

Now for U(1) we should have 1 instead of 2; but with the three electrons we have two symmetries in resonance with each other. And we get the product $N\,P = 1$ for the photon and the neutrinos; hence, all along, it looks like we only counted all combinations of possible unitary resonances given by the SM symmetries; a logic that extends to transmutations.

9 Conclusion

Based on a single hypothesis used to study the parameters of the standard models of particle physics and cosmology, we found a suite of formulas, coherent with each other, showing how it holds from the mass of neutrinos to the energy parameters of cosmology – down to the last known decimal places; and some ideas, new or otherwise, about the internal structure of the system under study: *A unique resonance where each and every quantity we addressed is a dynamical substructure.*

Each one of those appear to be part of a single physical object, which expression is found in the Planck mass oscillator, and where each formula speaks directly of the others in various manners. Therefore, we have most probably discussed the shapes of an unknown or poorly understood level of physical reality – some information hidden in the structures of space-time and fundamental particles.

Hence, in conclusion, highlight that the expressions (106) and (108), together with the suite h_i and c_i, seem to reveal the nature of quantum mechanics as they fit the de Broglie-Bohm [3] [2] and Cramer [9] interpretations – where 4-space, space-time, and strings, are ringing as a whole, permanently communicating between any two epochs down to the origin in one Planck time. Of course energy cannot be transferred instantly between any two points in space and time – of course; but now energy, what is it made of?

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