New Approach to Elementary Particles

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Abstract

This work develops a unified ontological framework for understanding the emergence of particle masses. Building upon the philosophy of Ruđer Bošković and the use of Planck parameters, we propose a model in which the masses of W and Z bosons, mesons, and baryons arise from an internal quantum–geometric equilibrium, rather than from external mechanisms such as the Higgs field.

Meson masses are calculated through iterative procedures applied to bare quark masses, utilizing bit-oriented exponents to capture a discrete informational structure. This approach reproduces the observed meson mass patterns and introduces an "effective gluonic correction" as the binding component.

Baryon masses are derived analogously from constituent quarks. The model achieves high accuracy (with deviations of less than 1%) while remaining parameter-free, mathematically rigorous, and conceptually transparent.

Overall, this framework offers a minimalistic and ontologically grounded alternative to standard quantum chromodynamics, positing that particle masses are an emergent consequence of fundamental quantum–geometric symmetries.

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1. Leptons and quarks

The relations shown here are either insufficiently known or have not been previously noticed. If there are more precisely established relations, I would greatly appreciate any comments and suggestions.

The emergence of real mass from virtual mass is referred to in Quantum Field Theory[1], *as an excited state.*

Quantum Field Theory treats particles as excited states (also called quanta) of their underlying fields, which are, in a certain sense, **more fundamental** than the elementary particles.

The masses of elementary particles are given in Table 1, which includes only the essential values. Masses are reduced with respect to the mass of the fundamental particle:

$$m/m_f \quad (m_f = 1.08862171*10^{-28}kg).$$

The distance is expressed as:

$$r/r_f \quad (r_f = 3.231309*10^{-15}m)$$

so that redused $r_f = 1$ and $m_f = 1$. This makes handling the smaller values easier and also simplifies the expressions for the dimensionless limits of elementary particles:

the *non-cohesion* $r = m^{\wedge 0.5}$

and the *cohesion* $\lambda\!\!\!^{-} = 1/m$

The hypothesis that leptons and quarks follow a simple relation yields formulas for the masses of the second and third generations using the constants α^{-1} and μ. In Table 1, Δp plays a central role, while p_β, linked to the proton and electron masses, appears for all quarks, simplifying the formulas.

$$p_\beta = m_f * 2^{8\Delta p/9} * \beta^{-2/3}$$

where $\beta = r_{ce} / \lambda_p$

[1] https://www.britannica.com/science/quantum-field-theory

r_{ce} – classical electron radius,
λ_p – proton Compton wavelength,

The quark masses are denoted by the initial letter of their English name. The results have been converted into [MeV/c^2] using the constant K given in the header, in order to allow comparison with measured values from the literature. An almost perfect agreement has been established, although whether these are genuine relations or coincidences remains open to discussion.

The following regularities, which appear in the formulas, support their validity:

- The constant α^{-1} appears in parentheses for the second-generation quarks;
- The constant α^{-4}, i.e. $(\alpha^{-1}-1)$^4, appears in parentheses for the third-generation quarks;
- The constant T appears for ***up***-type quarks;
- Conversely, T^-1 appears for ***down***-type quarks.

Table 1 – Leptons and Quarks (masses in MeV/c² and reduced units)

	$2\pi, \alpha^{-1}, \beta =$	**6.283185307**	**137.035999084**	**2.132525586**
	$cy = e^{2\pi}$, Δp, $T = m_\tau/m_{mu}$	*535.491656*	1.935060944	**16.816735**
	$p_\beta = m_f*2^{8\Delta p/9}*\beta^{-2/3}$	1.988497578	**K = [*f*] / [*MeV*]=**	**0.01637540297**
		***m* [f]**	***m* [MeV/c²]**	***mesured* [MeV/c²]**
(1.1)	$t = p\beta*[T*(\alpha^{-1}-1)^4*2^{-1}]^{1/3}$	2829.00748	172759.564	172760 ± 300
(1.2)	$b = p_\beta*(T^{-1}*\alpha^{-4}*2^{\wedge-9})^{\wedge(1/3)}$	68.54368	4185.77053	4180+40; −30
	tau - τ	29.096289387	1776.82891	1776,86 (12)
(1.3)	$c = p_\beta*(T*\alpha^{-1}*2^{-1})^{1/3}$	20.84685	1273.05897	1275 +25;−35
	$m_p(f) = m_p/m_f$	*15.36458*	938.27209	938,272 088 16(20)
	muon - mu	1.730198477	105.6583755	105,658 3755 (23)
(1.4)	$s = p_\beta*(T^{\wedge-1}*\alpha^{-1}*2^{-4})^{1/3}$	1.58800	96.97447	95+9; −3
	f=1	1	61.06720	
	$m_{el}(f) = m_{el}/m_f$	*0.0083678*	0.510998950179	0,510 998 950 00(15)

For the top quark in ***(1.1)***, the change in the formula with the invariant transition ***'1'*** arises from the completion of the class of quark phenomena.

In Table 1, the first-generation quarks are absent because, if we look from the bottom, the electron appears first, while in the upper half (above the fundamental particle) all elementary particles of the second and third generations are located. One could even conditionally say that the first generation branches into two second generations: second a and second b.

Neutrinos are also not included, yet it can still be concluded that all three lie below the fundamental particle, whereas quarks and charged leptons lie below it only in the first generation. This distinction is significant for understanding the properties of neutrinos.

2. Quantum "growth"

In Table 2 (below), we show how ***up*** and ***down*** quarks form the proton and neutron, through understanding the role of the fundamental particle and Bošković's *non-cohesion* and *cohesion* limits.

By sorting the elementary particles in Table 2 by descending mass, we observe that the two first-generation quarks — ***up*** and ***down*** — are located below the mass of the fundamental particle. It follows that their *non-cohesion* limit lies within the particle itself, meaning that they oscillate around the fundamental particle. In this way, they "capture" mass, causing their mass to "grow," which can be expressed by the formula:

$$m_1 = m*(1+\delta) \tag{2.1}$$

The addition $\boldsymbol{\delta}$ is called the *Planck addition*, and the entire process is referred to as *mass capture*. In this process, the constituent quark arises as an excitation of the quantum field, through a *quantum capture* — expressed as the ratio of unit action to the speed of light $\hbar$/**c**, with dimensions **[LM]**.

This is not a simple transformation of energy into mass (as in $\boldsymbol{m = E/c^2}$), but a **structural quantum state** established around the virtual fundamental particle. It follows:

$$\delta = \frac{\hbar / c}{r*m} = \frac{r_f * m_f}{r*m} \tag{2.2}$$

For the fundamental particle, among other things, it holds that:

$$r_f / r = \sqrt{m_f / m} \tag{2.3}$$

Now, it follows from (***17.2***) and (***17.3)*** that:

$$m_1 = m*(1+\delta) = m*\left(1+\frac{m_f^{1.5}}{m^{1.5}}\right) \tag{2.4}$$

If, for simplicity, we apply a system in which mass is dimensionless, reduced to the fundamental particle, then for any mass $\boldsymbol{x = m/m_f}$, equation ***(2.4)*** becomes:

$$x_1 = x*(1+\delta) = x*\left(1+\frac{1}{x^{1.5}}\right) \tag{2.5}$$

The formula shows that lighter quarks, through *mass capture*, acquire a more mass than the heavier ones. Let us further assume that particles can undergo multiple successive *captures*, so that, in general:

$$x_n = x_{n-1} * (1+\delta) = x_{n-1} + x_{n-1}^{-0.5} \qquad (2.6)$$

In other words, equation ***(2.6)*** can be applied multiple times, as illustrated in Table 2.

Table 2 – Quantum "Growth" of Up and Down Quark

	2π, α^{-1}, μ =	**6.283185307**	**137.035999084**	**1836.15267343**
	$\Delta p = 2 - 1/(\mu*\alpha+2)$, cy, k	**1.9350609435**	***535.491655525***	**2.00045025459**
		n = $\log_2(M_u/m)$	$r = K_r*2^{-n/2}$	$m = K_m*2^{-n}$
	Universe	0.00000000	1.29165E+26	1.73945E+53
	$ne = p-q/(1+\alpha^{-2}*\log_2\mu)$	***265.808779550***	1.2674708E-14	*1.67492749787E-27*
	$p = cy/2 - \Delta p$	***265.810766819***	1.2665982E-14	*1.67262192369E-27*
	$f = cy/2+\log_2(2\pi)-\Delta p/3$	***269.752303577***	3.2313088E-15	1.08862171145E-28
	down - $d = k * m_u$	273.452887507	8.9615903E-16	**8.37317614E-30**
(2.7)	$m_u = \alpha^{-1/3}*\log_2(3)^{-1/4}*m_{el}$	274.453212260	6.3360881E-16	**4.18564577E-30**
	$m_{el} = m_p / \mu$	276.653237125	2.9558641E-16	**9.1093837015E-31**
(2.8)	$m_{gl} = m_p - m_f*(2*m_{u2}+m_{d2})$	278.765793910	1.4213891E-16	**2.1064251718E-31**
	$q = 3cy/4+3\log_2(2\pi)/2-\Delta p/2$	***404.628455366***	1.6161988E-35	*2.72338853E-69*

Mass increase First solution

(2.6b)	$x_0 = m/m_f$	$x_1=x_0+x_0^{-0.5}$	$x_2 = x_1+x_1^{-0.5}$	$x_3 = x_2+x_2^{-0.5}$
down	0.076915388109	3.68264687278	4.20374553918	4.69147814536
up	**0.038449038126**	**5.13829736664**	**5.57945153060**	**6.00280609397**
(2.9)			$m_{ne} = m_f*(u_3+2*d_3)$=	*1.67492749791E-27*

Mass increase Second solution

(2.6c)	$x_0 = m/m_f$	$x_1= x_0+x_0^{-0.5}$	$x_2 = x_1+x_1^{-0.5}$	$x_3 = x_2+x_2^{-0.5}$
down	3.11615960468251	3.68264687254	4.20374553896	4.69147814515
up	**4.67584170590061**	**5.13829736664**	**5.57945153060**	**6.00280609397**

We use the heuristically obtained mass of the bare ***up*** quark from the electron mass (other solutions are possible, including even imaginary ones):

$$m_u = \alpha^{-1} * m_{el} / (\log_2 3)^{1/4} \qquad (2.7)$$

Within the framework of standard particle physics, the proton is described as a system composed of two up quarks, one down quark, and a complex gluon structure. Regardless of whether gluons are interpreted as binding energy, an entity, or in some other way, in this model we denote by m_{gl} the total effective mass contributed to the proton by this gluon structure.

$$m_p = 2 * m_u + m_d + m_{gl} \qquad (2.8b)$$

The neutron, on the other hand, is composed of one ***up*** quark and two ***down*** quarks:

$$m_{ne} = m_u + 2 * m_d \quad \textbf{(2.9)}$$

From the previous formulas, we obtain Table 2 in the SI (MKS) system, assuming that the neutron mass is obtained after the third iteration ***(2.6)*** from two ***down*** quarks and one ***up*** quark (which is possible under the condition m_d/m_u = 2,00045025459331).

From formula ***(2.8b)***, the **remaining mass** corresponds to the gluon, m_{gl}, which is shown in the table as ***(2.8)*** and will later be used in the case of bosons. We thus obtain:

- The proton is a double mass capture of two up quarks, one down, and the gluon mass;
- The neutron is a *triple mass capture* of one up quark and two down quarks.

The essential point is that material structures are composed from Bošković's ***non-extended*** points, although they do not literally arise from them.

3. Bosons

A significant amount of time in this work was devoted to converting between different unit systems — in the table below, this conversion is performed twice. Since elementary particles have masses close to that of the fundamental particle, it is convenient, in the case of bosons, to express their masses dimensionlessly, relative to the mass of that particle (intentionally denoted by a lowercase letter).A significant amount of time in this work was spent converting between different unit systems — in the table below, this is done twice. Since elementary particles have masses close to that of the fundamental particle, in the case of bosons it is convenient to express their masses *dimensionlessly*, relative to the mass of that particle (intentionally denoted by a lowercase letter).

The second conversion is into the commonly used system for boson masses**, [GeV/c²]**, in order to compare with measured values. Such a representation allows one to rely on the principles of nature, starting from the assumption that nature is rational — which permits boson masses to be expressed through simple relations.

Moreover, this approach follows Bošković's idea, rooted in ancient philosophy and closely related to Mach's principle, according to which *universal interconnectedness governs nature*.

Bosons, besides their mutual relations, also exhibit rational relations with quarks. It is often stated that the gluon exists in the proton as a massless particle. On the contrary, I consider that resolving this issue can contribute to a deeper understanding of the very nature of bosons.

It is important to note that for bosons, instead of the classical factor 2π a *logarithmic expression* appears:

$$L = \log_2(8\pi)$$

Formula ***(3.1)*** in table 3 connects trigonometric functions, the bit ***'2'***, and the unit ***'1'***, giving the ratio of the ***w*** and ***z*** boson masses:

$$x = m_W/m_Z$$

On both sides of the equality appears the *coupling constant* ***g***, specifically shown in ***(3.2)*** in table 3, which here unifies two different mathematical operations. This illustrates the general principle of how *nature proceeds from the non-extended and massless to the extended and material* (see Section 8 for further details).

The expected mass of the neutrino ν, obtained from expression ***(3.3)***, is not the result of empirical fitting, but rather represents an ideal value that ontologically connects the bosons through the logarithmic expression $L=\log_2(8\pi)$. This quantity acts as a **connector among bosons**, enabling their exponential relation, similar to how 2π links spatial relations.

However, the Higgs boson mass, expressed as $2^{11}=2048$ from ***(3.3b)***, has a deeper foundation: it represents a minimal quantum "bitwise" form, carrying only whole bits with no *partial bits*, that is, the smallest number of degrees of freedom required to maintain its scalar status. As such, the Higgs does not participate in multiple degrees of freedom and represents a minimal form. Its value lies in ontological closure.

The gluon mass, which is inside the proton, is smaller than the mass of the fundamental particle and is determined using formula ***(2.8)*** from the previous chapter, here converted into ***(3.6)***. A roughly identical result is obtained using the bit representation, which in inverse form is shown in ***(3.6b)***, and may be significant for further investigations.

To avoid speculation, the table uses the **measured** value for ***z***, 19.876 [**GeV/c²**] in ***(3.4)***, with formula ***(3.1)*** applied to determine ***w***. In the table, boson masses are given in **[GeV/c²]**, while quark masses were previously expressed in **[MeV/c²]**.

Heavy bosons (***higgs, z, and w***), in the logarithmic representation (column ***n***), are located in the domain: $n < f$ or, with their *non-cohesive* limit, $n + n/2 < q$. In contrast, light bosons, the gluon and the photon, satisfy: $n > f$ ili $n + n/2 > q$.

Table 3 – Mass of Bosons

	[jedinični]→[GeV/c^2]	Conversion	1.024842719E-80	
	[f] / [GeV/c^2] = [jed.] *2^f	factors	16.37540298	
	L = $\log_2(8\pi)$	4.651496129	[f] / [GeV/c^2]	
(3.1)	1 - (2 - $2^{0.5}$) * $\sin(x)^2$ =	$[(x^{-2}-1)^{0.5}+1]^{-1} \rightarrow x$ =	0.8814836261	
		Coupling	constant g	
(3.2)	g = 1/ [$(x^{-2}-1)^{0.5}$ + 1] =	0.6511670157	1-(2-$2^{0.5}$)*$\sin(x)^2$ =	0.6511670157
	Bosons	***Relative to the f.p.***	***[GeV/c^2]***	***measured [GeV/c^2]***
	f =	1.000000000000	0.061067199	1
(3.3)	$v^* = L^8 * z^{-1/2} * w^{-1/4} * f^0 * g^{-1/8}$	2055.92980266	125.5498753	—
(3.3b)	*h* =2^11	2048	125.0656245	125.10 ± 0.14
(3.4)	*z = zadato*	1493.23369663	*91.1876*	91.1876±0.0021
(3.5)	*w* = *x* * *z*	1316.26105347	80.3803763	80.379±0.012
(3.6)	$gl = m_p-(2*m_{u2}+m_{d2})$	0.00193495	0.000118162	—
(3.6b)	gl^{-1}=2^(3+1/12)/(2^10-2^7)^(1/12)+2^9	516.810056220	516.810056221	—

4. Koide formula

The world is simple, but not too simple

This thought is attributed to Einstein. We will apply it to the Koide formula, which owes its "fame" to its elegant appearance. At the cost of compromising this elegance, it must be adjusted to align with nature. A complicating factor is the fact that in the formula, the largest contribution comes from the tau lepton—the particle with the least accurately known mass—while the smallest contribution comes from the electron, whose mass is known with the highest precision.

Table 4 shows dimensionless masses and *non-cohesion* limits relative to a fundamental particle.

Formula ***(4.1)*** is the original Koide formula, which yields a result accurate to five decimal places using the 2018 CODATA values. A similar level of accuracy has been confirmed throughout the entire history of published CODATA reports. The following CODATA 2018 values in **[kg]** were used:

$$m_\tau = 3.167\ 54(21) *10^{-27} \text{ kg}$$

$$m_{mu} = 1.883\ 531\ 627(42) *10^{-28} \text{ kg}$$

$$m_{el} = 9.109\ 383\ 7015(28) *10^{-31} \text{ kg.}$$

Table 4 – Correction to the Koide Formula

cy = e$^{2\pi}$	***535.491656***	***α***	**0.007297352569**	
	n = $\log_2(M_u/m)$	$r = K_{rf}*2^{-n/2}$	$m = K_{mf}*2^{-n}$	
Universe	0.000000000	3.997306E+40	1.5978455E+81	
tau - τ2018	264.889515	5.3941443	29.0967925	
p = cy/2 - Δp	***265.810767***	3.919768303	*15.364583547*	
muon - mu	268.961366	1.315370091	1.730198477	
f = cy/2+log₂(2π)-Δp/3	*269.752304*	1.000000000	1.000000000	
el = p + log₂µ	*276.653237*	0.091475755	0.008367814	
Based on the previous context, the Koide formula is:				
Original formula $(m_{el}+m_{mu}+m_\tau) / (\sqrt{m_{el}}+\sqrt{m_{mu}}+\sqrt{m_\tau})^2$			0.666660490512	***(4.1)***
with *non-cohesion* limits $(m_{el}+m_{mu}+m_\tau) / (r_{el}+r_{mu}+r_\tau)^2$			0.666660490512	***(4.2)***
with fund. particle $(m_{el}+m_{mu}+m_\tau) / (r_f*\alpha^{0,5}+r_{mu}+r_\tau)^2$			0.667848404080	***(4.3)***
$\Delta f = (m_{el}+m_{mu}+m_\tau) / (r_f*\alpha^{0,5}+r_{mu}+r_\tau)^2 - 2/3$			0.001181737413	***(4.4)***

Like most others, we believe there is something to it, but its absolute accuracy is questionable. If we look at the table, we see that the electron is below the fundamental particle, while the other two leptons are above. Therefore, it is not natural for all three leptons to have the same "weight" in the Koide formula. From Boscovich's *unextended* to the *extended*, the electron appears first. There must be some transition that enables the branching into the other two leptons.

Furthermore, it is clear that in the second parenthesis of the dimensionless masses, we can also replace them with the dimensionless *non-cohesion* limits, thus obtaining ***(4.2)***, with an identical result. In this way, we have linked the lepton masses to their *non-cohesion* limits, which are the meaning of the values in the denominator of the Koide formula. This limit can only be a consequence of the fine-structure constant, which is related to the electron, leading us to (***4.3***). Without further correction, this gives results accurate to only two decimal places.

It is impossible for the universe as a whole not to influence the leptons, so let's calculate the correction from the ideal value of **'*2/3*'**, formula (***4.4***). This value has its origin relative to the step ***f*** = *269.752304*, giving us:

$$\Delta f = 1/\left(x^* * f\right) \qquad \textbf{(4.5)}$$

Where $\boldsymbol{x^*}$ is the value we are seeking. Calculating for x^* yields ***(4.6)***:

$$x^* = 1/\left(\Delta f * f\right) = \;\; 3.136995 \qquad \textbf{(4.6)}$$

The result is $x < \pi$, for the tau lepton mass from CODATA 2018. However, using values from the CODATA 2010 and 2014 reports gives $x > \pi$, which leads to the conclusion that the actual value of the tau lepton mass lies between these values and that it is likely that $x^* = \pi$. Meanwhile, formula ***(4.7)*** yields results an order of magnitude more accurate than the original throughout the history of CODATA reports:

$$\left(m_{el}+m_{mu}+m_{\tau}\right)/\left(r_f\alpha^{0.5}+r_{mu}+r_{\tau}\right)^2-1/\left(\pi f\right)=0.666668396 \qquad \textbf{(4.7)}$$

This is illustrated in the following calculation — the first row of the Excel table uses the CODATA 2018 values, while in the second row, applying the same formula with the same electron and muon masses and the tau particle mass from the table (m_τ) yields an exact 2/3.

formula (4.7) sa CODATA 2018	0.6666683960428
formula (4.7) m_τ=3,1674852519*10^{-27} kg	0.6666666666667

From the previous analysis, it is clear that formula ***(4.7)*** can be expressed exclusively in terms of the *non-cohesion* limits, where the denominator contains the limits themselves, and the numerator contains their squares. In the used system where

$$r_f=1 \text{ and } \xi=2^{\wedge(4/3-1/(3\pi\beta+3))}/\beta$$

(β - the ratio of the classical electron radius to the reduced Compton wavelength), the expression further simplifies to the form:

$$\left(\xi\alpha+r_{mu}^2+r_{\tau}^2\right)/\left(\alpha^{0.5}+r_{mu}+r_{\tau}\right)^2-1/\left(\pi f\right)=2/3 \qquad \textbf{(4.8)}$$

In this form, the electron does not appear; rather, only key constants and the non-cohesive limits of the muon and tau particle are present. The usefulness of this formula is further demonstrated by solving it for the mass of the tau lepton, which results in a quadratic formula, and by its testing through CODATA reports in Section 7.

5. Radii via key constants

Here we use the Reciprocal of the Rydberg constant $R_y = 1/R_\infty$, the Classical electron radius – r_{ce}, the Compton wavelength – λ_p, the Fundamental limit – r_f, and the dimensionless constants, which I reiterate before the following table.

The values obtained from known formulas are presented in the first and second columns of the table. The third row of the table contains the hypothesized formula for the proton charge radius – rpc, derived from the known quantities λ_p and the constant ξ, as we consider to be key for the relationships within these structures:

$\alpha^{-1} =$	*137.035999084*	$r_f =$	*3,23131E-15*
$\beta = r_{ce} / \lambda_p$	*2.132525586*	$\lambda_p =$	*1,32141E-15*
$\xi = 2^{\wedge\, 4/3\, -1/(3\pi\beta+3)} / \beta$	*1,14669171435*		

Table 5 – Key Radii from Fundamental Constants

1	2	3	4	5
$R_y = 1/R_\infty$	9.11267E-08	$r_y/r_f = \xi^{\wedge-1} * \acute{\alpha}^{\wedge 3} * 4\pi$	2.820117E+07	2.820117E+07
r_{ce}	2.81794E-15	$r_{ce} / r_f = \xi^{-1}$	0.8720739737	0.8720739737
$r_{pc} = \lambda_p * \xi^{\wedge-3}$	8.7639E-16	$r_{pc} / r_f = \xi^{\wedge-4} * \beta^{\wedge-1}$	0.2712183389	0.2712183389

Zatim smo smenama, sveli odnos ovih radijusa prema referentnom radijusu – r_f, na odnose konstanti, π, α^{-1}, β i ξ i dobili identičan odnos u kolonama 4 i 5. Time smo sve ove značajne radijuse izrazili preko ključnih konstanti.

Then, through substitutions, we reduced the ratio of these radii relative to the reference radius – r_f, to ratios of the constants π, α^{-1}, β and ξ, and obtained identical relationships in columns 4 and 5. In this way, we have expressed all these significant radii in terms of key constants.

Now, let us also present the formulas with constants in mathematical format within the MKS system:

$$R_y = r_f * 4\pi * \xi^{-1} * \acute{\alpha}^3 = 9.11267 * 10^{-8} m \qquad \textbf{(5.1)}$$

$$r_{ce} = r_f * \xi^{-1} = 2.81794 * 10^{-15} m \qquad \textbf{(5.2)}$$

And a particularly significant relation for the root mean square charge radius of the proton (proton RMS charge radius, CODATA 2014 is 0.8751×10^{-15} m), which in the MKS unit system is expressed as:

$$r_{pc} = r_f * \xi^{-4} \beta^{-1} = 8.7639 * 10^{-16} m \qquad \textbf{(5.3)}$$

The value obtained from formula ***(5.3)*** shows agreement with the results of electron spectroscopy, which can be explained by the following reasons:

1. While other factors have a dominant influence on the result, ξ represents a highest-order correction—a precise fine-tuning of the value, for which no other constant exists that would allow for finer adjustment.
2. Any change in the exponent of ξ for ±1 leads to results that fall outside the range of experimental measurements.
3. The constant ξ has proven useful in numerous other applications in physics.
4. The transition from the linear form (electron) to the spatial form (proton) occurs through a simple and expected relation ***(5.4)***:

$$\left(r_f / \mathrm{r}_{ce}\right)^3 = \lambda_p / r_{pc} \quad \textbf{(5.4)}$$

The values of the first two radii are well-established and can be expressed in terms of the fundamental particle and key constants. Since this holds true for all radii, the same principle applies to the third, less-known radius, as well as to other significant radii.

The proton is particularly significant. Let us calculate its length-dimensional parameters and present them relative to the reference radius of the fundamental particle, as shown in the following table:

Table 5b – Proton Radii from Fundamental Constants

$r_{pc} / r_f = \xi$^-4 * β^-1	0.2712183389	0.2712183389	***(5.5)***
$\lambda_p / r_f = \xi$^-1 * β^-1	0.4089395126	0.4089395126	***(5.6)***
$ƛ_p / r_f = \xi$^-1 * β^-1 *(2π)^-1	0.0650847449	0.0650847449	***(5.7)***
$r_{necoh} / r_f = \xi$^0,5 * β^0,5 *(2π)^0,5	3.9197683028	3.9197683028	***(5.8)***

Furthermore, it is clear that knowing one parameter enables the determination of the others using the mutual relationships provided in the table. In Table 5b, the radii associated with the proton are listed in order of magnitude: the cohesive radius (reduced Compton wavelength), the charge radius, the Compton wavelength, and the *non-cohesion* radius.

By multiplying the dimensionless ratios by the radius of the fundamental particle, the corresponding values in the MKS system are easily obtained. The final *non-cohesion* radius, $\boldsymbol{r_{necoh}}$, can be obtained, for example, using the formula in the MKS system

$$r_{necoh} = r_f * \left(m_p / m_f\right)^{0.5} = 1.2665982 * 10^{-14} m \quad \textbf{(5.9)}$$

or for the dimensionless case where $r_f = 1$, we obtain the value from the table: 3.9197683028.

6. Masses of bare and constituent quarks

The goal of this section is to apply the formulas from Section 2, "Quantum Growth," to calculate the masses of constituent quarks from bare quarks. Definitions of bare and constituent quarks can be found in numerous online sources.

We use formula ***(2.6)*** here again as ***(6.1)*** to calculate the quantum mass growth of a quark, where $\boldsymbol{x}$ is the dimensionless mass obtained by reduction with the Fundamental mass – $\boldsymbol{m_f = 1.088621711*10^{-28}}$ kg. The approach illustrates quantum action at the fundamental limit, and the values are presented in two systems: reduced with the mass at step $\boldsymbol{f}$, and using the coefficient from the table header in **[MeV].**

$$x_n = x_{n-1} + x_{n-1}^{-0.5} \quad (6.1)$$

Where *"–1"* denotes the previous mass in the iteration.

Table 6 – Masses of Bare (x_0) and Constituent Quarks

Iz Tabele 1	x_0 = [m/m_f]	[fc] / [MeV]	0.0163754030	
čestica	[MeV]	I	II	III
top	2829.01 172760	2829.03 172761	2829.05 172762	2829.06 172763
bottom	68.54368 4185.77	68.664 4193.15	68.785 4200.52	68.906 4207.88
charm	20.84685 1273.06	21.066 1286.43	21.284 1299.74	21.501 1312.98
strange	1.587996 96.97	2.382 145.43	3.030 185.01	3.604 220.09
fundamentalna	1.00000 61.07	2.000 122	2.707 165	3.315 202
down	0.07691539 *4.70*	3.683 *224.89*	4.204 *256.71*	4.691 *286.50*
up	0.03844904 2.35	5.138 313.78	5.579 340.72	6.003 366.57

In the process of mass "growth," the mass of a constituent quark in the next iteration increases by the binding energy (gluon field) within the radius of the Boscovich non-cohesive limit of the bare or previous quark. Formula ***(6.1)***, applied to the data in Table 7, confirms the empirical fact: for heavier quarks, the difference between bare and constituent masses is small, while for lighter quarks, it becomes significant. The top quark practically does not change its mass over three iterations, while the up quark increases its mass by approximately ~156 times.

Even a virtual fundamental particle gains mass through iterations, indicating constant changes—the point without attraction/repulsion loses this property, while another point takes it over. The solutions of ***(6.1)*** in this case can also be complex, for example:

$$x \approx 0.1231 - 0.7444i \quad \text{i} \quad x \approx 0.1231 + 0.7444i$$

Table 6 shows how far each quark is from the point without attraction or repulsion ($m_f = 1$ in units of the fundamental mass). The strange quark (m_s = 1.588) is particularly close to this point, which may have profound physical significance.

The mass of the bare up quark can take on different values (real and complex), as shown in Table **6b** using the example of two real bare up quark masses, both of which yield a neutron after three successive applications of formula ***(1)*** in units with the mass of the fundamental particle $m_f = 1$.

Table 6b – Bare and Constituent Masses of Two Up Quarks (ua, ub)

m_o [kg]	*particle*	m_o [m_f = 1]	$m = m_{-1} + m_f^{1.5}/m_{-1}^{0.5}$ [m_f = 1]		
1.0886217E-28	**f - fund. p.**	1.00000000	**I**	**II**	**III**
8.3731761E-30	**d - down k.**	0.07691539	3.6826468737	4.2037455400	4.6914781461
4.1856458E-30	**ua**	0.03844904	5.1382973662	5.5794515302	6.0028060936
5.0902228E-28	**ub**	4.67584171	5.1382973662	5.5794515302	6.0028060936
1.6749275E-27	***ne*-neutron**	**15.385762386**		$ne = ua_3 + 2*d_3$	**15.385762386**
				$ne = ub_3 + 2*d_3$	**15.385762386**

Both cases yield the same neutron mass from the bare particle masses, x_0. Below column III is the neutron, composed of one ***up*** and two ***down*** quarks.

For easier understanding, the masses are presented in **[kg]** (first column) and relative to the fundamental particle (third to sixth columns). We observe that two real bare up quark masses (***ua*** and ***ub***) yield the same neutron mass (bottom right), leading to the conclusion:

In the macro world, galaxies, stars, etc., differ from one another; the same holds true in the subatomic world.

The possible number of such points is infinite, but not the number of existing ones, which is Boscovich's stance, [1, paragraph 90]:

"*…Thus, there is only an infinity of possible points, not an infinity of existing points…*"

Iterative processes of mass addition to quarks are key to understanding the formation of hadrons. Special Sections 9 and 10 are dedicated to this issue.

7. Tau lepton mass: measured and by formula

Since the tau mass is the least accurately measured among the leptons, its value was obtained using the quadratic formula derived from relation ***(4.7)***. Table 7 presents the results for three CODATA reports (2014, 2018, 2022), illustrating the procedure, while Table 7b shows the corresponding relative errors for seven reports (1998–2022).

Table 7 – Procedure for Determining the Tau Lepton Mass

t=log(2π,2)	2.651496129	cy=exp(2π)	535.4916555
	2014	**2018**	**2022**
m_p =	1.672621898E-27	1.67262192369E-27	1.67262192595E-27
m_e =	9.10938356E-31	9.1093837015E-31	9.1093837139E-31
$\mu = m_p/m_e$	1836.1526738	1836.15267343	1836.1526734
α^{-1} =	137.035999139	137.035999084	137.035999177
CODATA mu	1.8835316E-28	1.883531627E-28	1.8835316E-28
CODATA tau	3.16747E-27	3.16754E-27	3.16754E-27
A = e + mu	**1.892641E-28**	**1.892641E-28**	**1.892641E-28**
$\Delta p=2-1/(\mu*\alpha^{-1}+2)$	**1.935060944**	**1.935060944**	**1.935060944**
$\zeta=2\pi\acute{\alpha}*2$^$(2\Delta p/3)/\mu$	**1.146691715**	**1.146691714**	**1.146691715**
$B=sq(m_e/\zeta)+mu^{\wedge 0.5}$	**1.46155E-14**	**1.46155E-14**	**1.46155E-14**
$s=\pi*(cy/2+t-\Delta p/3)$	**847.4518552**	**847.4518552**	**2521.418586**
K=2/3+1/s	**0.667846675**	**0.667846675**	**0.667063269**
Izračunato $m_\tau=((2KB/(1-K)+sq((-2KB/(1-K))^{\wedge 2}-4*(A-K*B^{\wedge}2)/(1-K)))/2)^{\wedge 2}$			
	3.1674852E-27	**3.1674852E-27**	**3.1427777E-27**
$(m_e+m_{mu}+m_\tau)/(\sqrt{(m_e/\zeta)}+\sqrt{m_{mu}}+\sqrt{m_\tau})^{\wedge 2}-1/s$			
	0.666666666667	**0.666666666667**	**0.666666666667**

The relative errors as percentages (formula-measured), are in the last column of the table below.

Table 7b – Relative Errors by Year of CODATA Reports

Godina	CODATA	Formula	R_{err} %
1998	3.16788.E-27	3.167484.E-27	**-0.0125**
2002	3.16777.E-27	3.167485.E-27	**-0.0090**
2006	3.16777.E-27	3.167485.E-27	**-0.0090**
2010	3.16747.E-27	3.1674850.E-27	**0.0005**
2014	3.16747.E-27	3.1674852.E-27	**0.0005**
2018	3.16754.E-27	3.1674852.E-27	**-0.0017**
2022	3.16754.E-27	3.1674852.E-27	**-0.0017**

Key Observations:

- The largest deviations of CODATA values from the formula occurred in 1998 (0.0125%) and 2002/2006 (~0.009%). In the years 2010–2022, errors were below 0.002%, indicating improved accuracy.
- The relative error of the formula compared to CODATA values is negligibly small (as low as 0.0005% for 2010 and 2014!). This confirms the formula's internal consistency over the entire period and demonstrates exceptional stability:

- The formula dominates, but the key question remains whether it is also accurate. CODATA shows convergence toward the formula's values over time, though with a residual deviation (~0.0017% in 2018/2022).

8. Mass ratio of the W and Z bosons

The intuitive–heuristic formula ***(8.1)*** presented here is also based on the approach developed within this work and relies on the ***Theoria philosophiae naturalis*** of Roger Joseph Boscovich.

The hypothesis is that the masses of the ***W*** and ***Z*** bosons arise as a consequence of a quantum–geometric equilibrium. This equilibrium is expressed as a reciprocal relation between the oscillatory (quantum) and the spatial–deformational (geometric) components, which condition one another through a precise mathematical relation. The equation that unifies trigonometric and hyperbolic functions shows that the masses of both bosons originate from the same source, while their proportionality is maintained through a universal binding constant.

The the conventional model predicts that the masses of the ***W*** and ***Z*** bosons emerge via the Higgs mechanism, in which interaction with the Higgs field leads to the appearance of mass. Although empirically successful, this approach does not explain why the masses take on their specific values, nor does it provide a deeper account of their origin.

According to the alternative hypothesis, the masses of the ***W*** and ***Z*** bosons arise from an internal quantum–geometric equilibrium, expressed by a transcendental equation in which the product of quantum oscillation and geometric deformation is fundamental.

The basic equation is:

$$\left[1-\left(2-2^{0.5}\right)*\sin^2\left(x\right)\right]*\left[\left(x^{-2}-1\right)^{0.5}+1\right]=1 \qquad \textbf{\textit{(8.1)}}$$

where:

$$x=m_W/m_Z \qquad \textbf{\textit{(8.2)}}$$

The left-hand side represents the product of two functionally independent components: the quantum

$$g=1-\left(2-2^{0.5}\right)*\sin^2\left(x\right) \qquad \textbf{\textit{(8.3)}}$$

and the geometric

$$1/g=\left(x^{-2}-1\right)^{0.5}+1 \qquad \textbf{\textit{(8.4)}}$$

Their product yields the identity:

$$g*1/g=1 \qquad \textbf{\textit{(8.5)}}$$

The product of these factors equals ***1***, whereby the binding constant ***g*** acts as a bridge between two domains: the quantum and the geometric.

The formula for the mass ratio of the ***W*** and ***Z*** bosons expresses a fundamental ontological equilibrium between two aspects of reality: quantum oscillation and geometric structure. The first term (the quantum factor) represents a *non-extended*, energetic impulse of oscillatory nature. The second term (the geometric factor) expresses the spatial structure and its response.

Their reciprocity conveys the dynamic balance between the quantum and the geometric level, where mass emerges as the natural transition from potential to the concrete. By solving the equation, we obtain numerically: ***x = 0.8814836260627656*** — which is not an experimental value, but a theoretical one. From this follows:

$$\sin^2(x) = 0.592012 \qquad \textbf{\textit{(8.6)}}$$

$$g = 1 - \left(2 - 2^{0.5}\right) * \sin^2(x) = 0.6511670157 \qquad \textbf{\textit{(8.7)}}$$

$$1/g = \left(x^{-2} - 1\right)^{0.5} + 1 = 1.5357043215 \qquad \textbf{\textit{(8.8)}}$$

The product of ***(8.7)*** and ***(8.8)*** through equation ***(8.5)*** equals ***1***, confirming the validity of the model. Unlike the Higgs mechanism, which postulates an external field with an arbitrary constant and a hierarchical relation between boson masses, the quantum–geometric approach derives the ***W*** and ***Z*** boson masses simultaneously from a single binding constant, as expressions of the dynamic symmetry between quantum impulse and the geometric structure of space. This reflects the principle of Occam's razor, favoring theories with fewer assumptions.

The expression in formula ***(4)*** functionally resembles the Lorentz factor, $\boldsymbol{\gamma = 1/(1-v^2/c^2)^{0.5}}$: in both cases the square root measures deviation from a limiting value — the speed of light, or in this model, the quantum component ***x***. The addition of +1 allows the ***Z*** boson, as neutral, to exceed the ***W*** boson in mass, analogous to the relativistic increase of mass with velocity. Just as the Lorentz factor introduces an inertial correction, here the square root provides a geometric correction of mass, marking the transition from the quantum to the spatial regime of reality.

The universal binding constant g expresses this equilibrium as a fundamental symmetry of reality — the passage from the non-extended to the extended. Formula ***(8.1)*** is therefore not only numerically accurate but ontologically necessary: boson masses emerge as intrinsic expressions of their mutual dynamics, rather than as externally imposed quantities. Formula ***(1)*** thus serves as a self-sufficient relation that ontologically links quantum impulse and spatial resistance, independent of the Higgs mechanism while not denying the existence of the Higgs boson

9. Iteration toward bit-oriented mesons

Mesons play a key role at the very origin of hadronization, where point-like quarks enter linear relations during the transition from Boscovich's *non-extended* to the extended. For this reason, we assume that mesons are predominantly formed already in the first iteration of bare quark masses by formula ***(2.6)***. For the purpose of calculating meson masses, we start from the following three assumptions:

1. The rho, pi, and eta mesons arise by summing the quark masses during the first iteration.
2. The neutral pi meson is taken from the accepted framework.
3. The coefficient ***'2'*** — i.e., the basic unit of information, the bit — is used with the exponents ***1/2*** and ***2*** for all of the mentioned mesons.

This is presented in the Table 9, where the first part contains the input values of quark masses in **[MeV/c²]** taken from the previous sections. Since the masses of the quark and antiquark are identical, the formula is simplified here.

The quark masses expressed in **[MeV/c²]** have been converted into dimensionless values in **[fc]** units. In column **"I"**, the total masses with their corresponding increments are displayed, determined by applying formula ***(6.1)***.

Table 9 – Meson Masses Derived from Quarks

	quark	mass [MeV/c²]	u [fc]	I			
	strange (**s**)	96.9745	1.58800	**2.4**			
	fundamental p.	61.06721	1	**2.0**			
	down (**d**)	4.6970	0.07692	**3.7**			
	up (**u**)	2.3480	0.03845	**5.1**			
	Meson formula	**measured**	**u [fc]**	**formula**	**[MeV/c²]**	**meas.-for.**	**R_{err} %**
9.1	**$\pi^{\pm}$= 2^-2*(u + d)**	139.570	2.2855	**2.205**	134.67	4.903	3.513
9.2	**π^{0}=2^0.5*(u - d)**	134.977	2.2103	**2.059**	125.71	9.264	6.863
9.3	**$\rho^{\pm}$=2^0.5*(u + d)**	775.11	12.6927	**12.475**	761.80	13.315	1.718
9.4	**ρ^{0}=2^0.5*(u + d)**	775.26	12.6952	**12.475**	761.80	13.465	1.737
9.5	**η=2^0.5*(u + d - s)**	547.862	8.9715	**9.107**	556.12	-8.258	-1.507
9.6	**η'=2^0.5*(u +d +s)**	957.78	15.6840	**15.843**	967.47	-9.690	-1.012

By summing, on the basis of the composition shown in the column "Meson formula," and the dimensionless masses in the first iteration, we obtain the dimensionless meson mass values in the column "formula" Converting them into **[MeV/c²]** yields the differences, in the same units, in the penultimate column between the measured and formula-derived meson masses.

These discrepancies could potentially be reduced by introducing a minor correction for the emergence of space, based on a rational assumption. Nevertheless, they can unequivocally be attributed to an '*effective gluonic correction*' that binds the quarks inside the meson and simultaneously contributes to its overall mass. The absolute discrepancy is greatest for the ρ mesons, whereas the relative difference is by far the largest for the neutral pion, for which we used the commonly accepted formula (see table).

The quark structure of π^0 and ρ^0 is formally similar, but due to their different spins, the mass expression in this model employs different bit exponents, resulting in clearly separated numerical values.

The question of a possible mass difference between ρ^0 and $\rho^\pm$ remains experimentally unresolved, in our theoretical framework, however, they are regarded as identical.

Since mesons consist exclusively of quark–antiquark pairs of equal mass, all meson formulas simplify. This is particularly illustrated by the original formula for the neutral pion:

$$\pi^0 = (u\underline{u} - d\underline{d}) / \sqrt{2} = 2 * (u - d) / \sqrt{2} = \sqrt{2} * (u - d) \qquad \textbf{(9.2)}$$

which we reduced to the expression shown in the Table 9. In the same way, the same simplifications apply to all other mesons.

The formula for the η meson in the prevailing theory:

$$\eta = (u\underline{u} + d\underline{d} - s\underline{s}) / \sqrt{6} \qquad \textbf{(9.5b)}$$

leads to a large error if used after the first iteration. Accuracy close to the experimental value appears only after 15 iterations, which is unacceptable for mesons with light quarks — effectively disqualifying this formula.

Interestingly, within this model, formula ***(9.5b)*** reduces to ***(9.5)*** in Table 9 simply by replacing $\sqrt{6}$ with $\sqrt{2}$. This adjustment not only yields markedly improved predictions with just a single iteration but also enhances simplicity, coherence, and a bit-oriented structure.

A similar situation holds for the η' meson. The accepted framework formula:

$$\eta' = (u\underline{u} + d\underline{d} + s\underline{s}) / \sqrt{3} \qquad \textbf{(9.6b)}$$

can be reduced to ***(9.6)*** in the Table 9 by replacing the root $\sqrt{3}$ with $\sqrt{2}$. The result is higher accuracy and consistency with the structure of the other mesons.

Since the iterations in this model are based on Planck's constant and the binary logic of the bit, the entire construction is rational, internally consistent, and free from external parameters.

The model achieves results without relying on traditional QCD parameters and is characterized by pronounced minimalism — without arbitrary adjustments, but solely through iterations connected with ***ħ*** and the bit.

For the charged kaon or antikaon, the same procedure shows that in the first iteration the ***u*** or ***ū*** participates, while the ***s*** or ***s̄*** comes from the second iteration. The neutral kaon and antikaon arise after 3 iterations of both constituents, which is the expected increase in the number of iterations due to the heavier bare quark or antiquark. In these cases, the relative gluonic contribution is similar to that of the other mesons.

10. Baryon masses from constituent quarks

For baryons, we extend to the three-dimensional structure of both particles and their bonds using formula (6.1). The masses in the "By formula" column were calculated from constituent quarks obtained through different iterations (a, b, c) of the initial "bare" quarks (abc), using dimensionless input data as previously done for bosons. The resulting values were then converted to **[MeV/c²]** with the appropriate transformation coefficient (Table 10).

This parameter-independent model achieves errors below 1% and is grounded in iterations linked to ***ħ/c***, showing that physical phenomena emerge as consequences rather than causes. Deviations from experimental values arise solely from the gluon field, represented in the "Measured − formula" column; for the neutron, the gluon content is zero, while for other baryons it is expressed relative to the proton.

This approach does not rely on λ_QCD, binding constants, renormalization, or fitting procedures. Its iterative structure naturally incorporates spin, symmetries, and quantum–statistical effects, based on Planck's constants and Boscovich's philosophy of forces. Compared to lattice QCD (1–5% errors) and perturbative QCD (invalid at low energies), it achieves high accuracy without heavy computations.

The iterations account for the bulk of hadron masses, with the gluon field as the only physical source of deviation. Hadrons may gain or lose a "quantum of grasp" (or, conditionally, a "quantum of space–mass," with dimension **[LM]**, describing the linear phase of transition from Boscovich's *non-extended* to massive spatial structure).

The " Measured - formula " column shows positive or negative values, indicating addition or loss of bound mass through environmental interaction. Further possibilities include iteration-weighted mass, testing the model on kaons and decays ***(e.g., ρ → π, η → 3π)***, and linking to decay widths ***(Γ(ρ → π) ≈ 150 MeV, Γ(η → 3π) ≈ 1 keV)***.

If someone asks: *"Why do the iterations yield the correct masses?"* the answer is: Because Boscovich's theory predicts such a structure of the universe. Whoever wishes to understand should study Boscovich.

Table 10 – Baryon Masses from Constituent Quarks [MeV/c²]

Baryons	Symbol	Composition	Measured	By formula	Measured - formula	RG %	Iterations a.b.c
proton	p	uud	**938.272**	938.154	0.118	0.0126	2.2.2
neutron	n	udd	**939.566**	939.5655	0.0000	0.0000	3.3.3
Delta ++	Δ^{++}	uuu	1232	1222.735	9.265	0.7578	5.5.4
Delta +	Δ^{+}	uud	1232	1219.642	12.358	1.0133	6.6.5
Lambda	Λ	uds	1115.68	1117.142	-1.459	-0.1306	6.6.6
Sigma$^+$	Σ^+	uus	1189.37	1188.757	0.613	0.0515	6.6.6
Delta°	Δ^0	udd	1232	1221.519	10.481	0.8581	7.7.6
Sigma^0	Σ^0	uds	1192.64	1191.887	0.753	0.0632	7.7.7
Delta-	Δ^-	ddd	1232	1225.108	6.892	0.5626	8.8.7
Sigma$^-$	Σ^-	dds	1197.45	1196.545	0.905	0.0756	8.8.8
Lambda$^+$c	Λ^+c	udc	2286.46	2291.446	-4.986	-0.2176	8.8.9
Ksi^0	Ξ^0	uss	1314.86	1304.452	10.408	0.7979	10.9.9
Ksi$^-$	Ξ^-	dss	1321.71	1311.963	9.747	0.7429	10.10.11
Sigma$^+$c	Σ^+c	uuc	2453.97	2457.673	-3.703	-0.1507	10.10.10
Sigma^{0}c	Σ^0c	udc	2452.9	2449.010	3.890	0.1589	11.11.11
Sigma$^-$c	Σ^-c	ddc	2453.75	2454.684	-0.934	-0.0380	12.12.13
Ksi$^+$c	Ξc^+	usc	2467.87	2469.266	-1.396	-0.0565	12.12.13
Ksi^{0}c	Ξc^0	dsc	2470.87	2472.792	-1.922	-0.0777	13.14.13
Ksi$'^+$c	$\Xi c'^+$	usc	2576.8	2578.060	-1.260	-0.0489	14.14.15
Ksi$'^0$c	$\Xi c'^0$	dsc	2578.0	2581.133	-3.133	-0.121	15.16.15
Double charmed b.	Ξ^+cc	ucc	3621.1	3617.442	3.658	0.1011	16.16.17
Omega$^-$	Ω^-	sss	1672.45	1677.113	-4.663	-0.2780	17.18.18
Lambda^{0}b	Λ^0b	udb	5619.6	5621.577	-1.977	-0.035	18.18.17
Charmed Omega^0	Ωc^0	ssc	2695.2	2700.553	-5.353	-0.1982	19.19.21
Charmed Omega+	Ω^+c	ssc	2765.9	2766.511	-0.611	-0.0221	20.20.19
Sigma$^+$b	Σ^+b	uub	5811.3	5807.793	3.507	0.060	20.20.25
Sigma$^-$b	Σ^-b	ddb	5815.5	5816.194	-0.694	-0.012	23.23.26
Bottom Omega$^-$	Ωb^-	ssb	6046.1	6047.472	-1.372	-0.0227	31.31.30

References

[1] Boscovich J. R.: (a) "Theoria philosophia naturalis redacta ad unicam legem virium in naturaexistentium", first (Wien, 1758) and second (Venetiis, 1763) edition in Latin language; (b) "A Theory of Natural Philosophy", in English, The M.I.T. Press, Massachusetts Institute of Technology, Cambridge, Massachusetts and London, England, first edition 1922, second edition 1966