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New approach to cosmology

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Abstract:
This paper presents Ruđer Bošković's conception of the multiverse and addresses the problem he posed regarding the precise value of the exponent in Newton's law of gravitation. Building further on Bošković's philosophy, several cosmological limits and relationships between planetary orbits in the Solar System are derived in an original manner. A specific parameter is introduced that distinguishes Earth from the other planets and may be a prerequisite for the emergence and development of life on celestial bodies. Kepler's third law is examined through an analogy with quantum phenomena. Finally, the temperature of the cosmic microwave background (CMB) is considered from a perspective different from that of mainstream science.

Keywords: Bošković, multiverse, gravitation, orbits, planets, cosmological limits, CMB

Contents

1. Bošković's universes

Mainstream scientists often use terms such as "parallel universes," "multiverse," and "expansion of the universe," which tend to create an impression of mystical and hard-to-grasp theories, as if science begins with them. I find it inappropriate that Bošković is rarely mentioned in these discussions. Nearly three centuries ago, he had already drawn and explained the diagram [1, fig. 14], reproduced here as Figure 1.

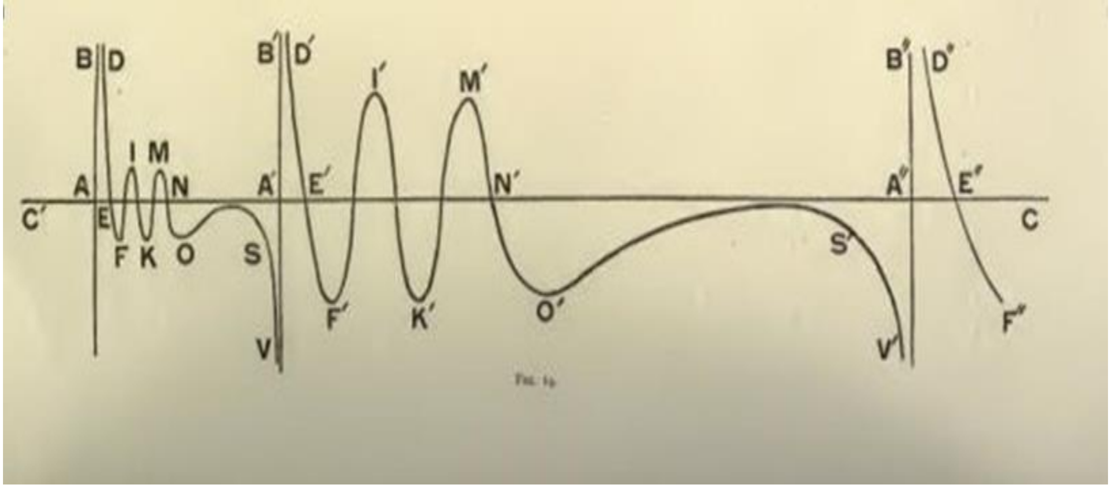

Figure 1 – Bošković's universes
A series of similar curves, with a series of universes proportional in magnitude

171. If, in Fig. 14, there are any number of segments AA', A'A", of which each that follows is immensely great with regard to the one that precedes it; & if through each point there passes an asymptote, such as AB, A'B', A"B", perpendicular to the axis; then between any two of these asymptotes there may be curves of the form given in Fig. i. These are represented in Fig. 14 by DEFI &c., D'E'F'I' &c.; & in these the first arm E would be asymptotic & repulsive, & the last SV attractive. In each the interval EN, where the arc of the curve is winding, is exceedingly small compared with the interval near S, where the arc for a very long time continues closely approximating to the form of the hyperbola having its ordinates in the inverse ratio of the squares of the distances; & then, either goes off straightway into an asymptotic & attractive arm, or once more winds about the axis until it becomes an asymptotic attractive arc of this kind, the area corresponding to either asymptotic arc being infinite...

Bošković further argued that there could exist any number of worlds, with none able to interact with another, since no point can pass from the space between two arcs—one repulsive and the other attractive. In this way, all universes of smaller dimensions taken together would amount to just a single point in the next one.

For Bošković, the key terms are the *non-cohesion* limit and the *cohesion* limit. Thus, a star whose radius exceeds the non-cohesive limit could not persist but would instead manifest as a nebula, since beyond that threshold irreversible repulsion prevails.

Half of the Schwarzschild radius [1] can be expressed as:

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[1] https://www.britannica.com/science/Schwarzschild-radius

$$\mathrm{r}_{cr} = Gm / c^2 \tag{1.1}$$

This would correspond to the radius of a black hole. In my view of the universe, it holds that:

$$\mathrm{G} = c^2 * R_u / M_u \tag{1.2}$$

Thus, if we consider the entirety of the universe in the above formula for $m = M_u$, we obtain $r_{cr} = R_u$. In other words, the universe itself behaves as a black hole.

Consequently, we can expect that every black hole represents a separate universe, including those within our own universe. Therefore, Bošković's rational assumption is justified:

all universes of smaller dimensions taken together amount to just a single point in the next one.

This supports the interpretation of a black hole as a point. Bošković anticipated the idea of other universes through a clear geometric representation, even at a time when galaxies were not yet known. Furthermore, the concept of black hole collisions can be understood as the interaction of extremely dense structures rather than singularities. I consider Bošković's view to be more rational, providing a clearer foundation for understanding these phenomena, although the issue remains open for further research.

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2. The exponent of the gravitational formula

Bošković, like some others, held that Newton's law of gravitation is not strictly exact, a point he emphasizes in several place. Let us quote from [1]:

170. If universal gravity obeys the law of a force inversely proportional to the square of the distance (which, as I remarked in the first part, it only obeys as nearly as possible, but not exactly), sensibly unchanged only throughout the planetary & cometary system, it will certainly be the case that the curve of forces will not have the last arm PV asymptotic with the straight line AC as the asymptote, but will again cut the axis & wind about it.

We present Newton's gravitational formula here in four equivalent expressions for gravitational acceleration:

Classical form:

$$g_n = -G*m*r^{-2} \tag{2.1}$$

Planck form:

$$g_n = -c^2*m*l_{pl}\Big/\left(m_{pl}*r^2\right) \tag{2.2}$$

Form with universe parameters:

$$g_n = -c^2*m*R_u\Big/\left(M_u*r^2\right) \tag{2.3}$$

Dimensionless form:

$$g_n = -\frac{m}{m_f}*\left(\frac{r}{r_f}\right)^{-2}*a_o \tag{2.4}$$

Here, the subscript $\boldsymbol{n}$ denotes the Newtonian component of gravitational acceleration, with the exponent exactly $\boldsymbol{-2}$ over distance.

Formula ***(2.2)***, which became known after Planck, allows for deeper insights than ***(2.1)***.

In ***(2.4)***, the masses are reduced with respect to the fundamental particle mass $\boldsymbol{m/m_f}$ ($\boldsymbol{m_f}$ = $1.08862171145*10^{-28}$kg). The distance is expressed as $\boldsymbol{r/r_f}$, relative to ($\boldsymbol{r_f}$ = $3.231309*10^{-15}$m). This representation is more convenient due to the smaller values, but it also simplifies the expressions for Bošković's limits: the *non-cohesion* limit $\boldsymbol{r = m^{\wedge 0.5}}$ and the *cohesion* limit $\boldsymbol{\lambdabar = 1/m}$ for elementary particles.

Among the presented relations, formula ***(2.4)*** is the most convenient, since both masses and distances are scaled with the constant acceleration $\mathbf{a_0}$. This means that in the dimensionless ratios $\boldsymbol{m/m_f}$ and $\boldsymbol{r/r_f}$, the exponent can take any value. At the reference step ***f***, the acceleration is equal to that at the level of the entire universe (without attraction and repulsion). Therefore, the coefficient from [3, Tables 1 and 1b] in the [kg–m–s] system is applied:

$$a_0 = 6.95818 * 10^{-10}\ m/s^2$$

The value of $\mathbf{a_0}$ is obtained by assuming a finite universe; not through our idea of spatial boundaries, but by the limited nature of the phenomena that characterize it. We will observe it in the vicinity of points **G, L**, and **P** on the abscissa of the Bošković curve, Figure 2. Here, a transition from attraction to recession occurs.

As an example, let us calculate the gravitational attraction at the Earth's surface using formula ***(2.4)***, which yields:

$$g_n = -\frac{5.97356*10^{24}}{1.08862*10^{-28}}*\left(\frac{6.37597*10^{6}}{3.23131*10^{-15}}\right)^{-2}*6.95818*10^{-10} = -9.80661m*s^{-2} \tag{2.5}$$

We obtain the same result as from ***(2.1)*** and as would be obtained from ***(2.2)*** and ***(2.3)***.

If in (2.4) we set $\boldsymbol{g_n = a_0}$, we obtain a *non-cohesion* limit:

$$r = r_f * \left(\frac{m}{m_f} \right)^{1/2} \tag{2.6}$$

which, when applied to Earth, yields:

$$r = 3.231311 * 10^{-15} * \left(\frac{5.97356 * 10^{24}}{1.08862 * 10^{-28}} \right)^{1/2} = 7.569341 * 10^{11} m \tag{2.7}$$

Here, $\boldsymbol{r}$ represents Bošković's *non-cohesion* limit (points G, L, P on Bošković's force curve):

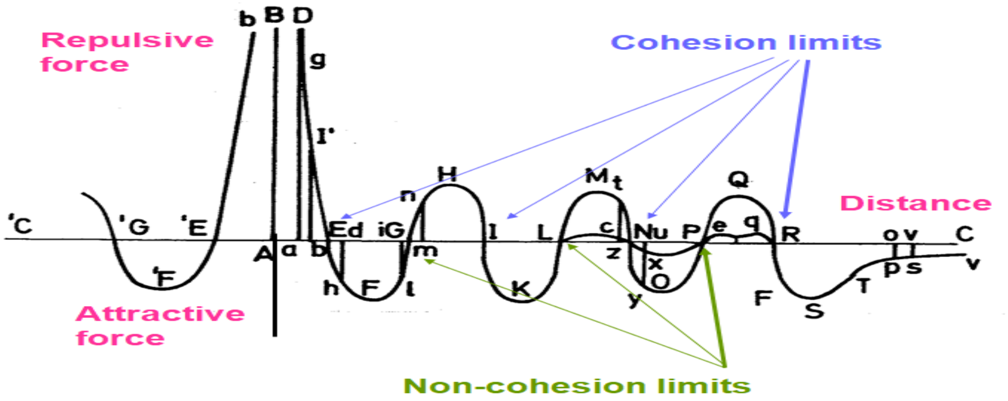

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Figure 2 - Bošković's curve of force

Shows the general shape of Bošković's curve, which illustrates the change of attractive and repulsive forces with the change of distance between entities (bodies or particles). The boundaries of non-cohesion and cohesion correspond to intersections with the abscissa where there is no repulsion or attraction on the curve [2].

This is a discrete quantity that applies only to the acceleration $\boldsymbol{a_0}$. We find that a particle located at this distance from Earth shows no tendency to move closer to it.

By applying formula ***(2.6)*** to the Sun, we obtain that the small bodies of the Oort cloud lie at a distance of approximately $\boldsymbol{10^{\wedge 14} m}$ from the Sun, where the unit acceleration is . Formulas ***(2.4)*** and ***(2.6)*** apply to all celestial bodies, but also to systems of celestial bodies.

But what occurs when gravitational acceleration ceases? Let us assume it is then replaced by:

the gravitational acceleration of the rest of the universe, g_s, since nature does not distinguish with which mass is involved.

Analogous to ***(2.4)***, for the rest of the universe we have:

$$g_s = \frac{M_u - m}{m_f} * \left(\frac{R_u}{r_f} \right)^{-2} * a_o \qquad \textbf{(2.8)}$$

Since the gravity of the rest is opposite to that of the body, it is positive—that is, *of the same kind as the body's gravity* but of opposite sign.

An expansion has been observed in galaxies, as expected at distances greater than the *non-cohesion limit*. At such scales, the attraction between neighboring galaxies becomes possible, and it is even conceivable that the gravitational influence of one galaxy extends to its neighbors. Bošković discussed this in sections 169 and 170 of [1], despite the fact that galaxies were not known in his time. Let us quote

169. The intermediate arcs, which wind about the axis, can also, at any point where they reach it, return backwards & touch it; and they can do this on either side of it; they may also be reflected and recede before actual contact, the approach being altered into a recession, as is to be seen in Fig. 2 with regard to the arc PefqR.

I consider Bošković to be correct, and therefore the formula for gravity ***(2.4)*** together with the gravitational effect of the rest of the universe ***(2.8)*** can be expressed as a sum:

$$g = g_n + g_s \qquad \textbf{(2.9)}$$

That is to say:

$$g = \left[-(\mathrm{m}/m_f) * \left(r/r_f \right)^{-2} + \left(M_u - m \right)/m_f * \left(R_u/\mathrm{r}_f \right)^{-2} \right] * a_0 \qquad \textbf{(2.10)}$$

which we then replace with a single exponent ***x***:

$$g = -m/m_f * \left(r/r_f \right)^x * a_0 \qquad \textbf{(2.11)}$$

By equating ***(2.10)*** and ***(2.11)***, we obtain:

$$\left(r/r_f \right)^x = \left[\left(r/r_f \right)^{-2} - \left(M_u - m \right)/m * \left(R_u/\mathrm{r}_f \right)^{-2} \right] \qquad \textbf{(2.12)}$$

Taking the logarithm and simplifying yields the formula for the exponent over distance:

$$x = \ln\left[\left(r/r_f \right)^{-2} - \left(M_u - m \right)/m * \left(R_u/\mathrm{r}_f \right)^{-2} \right] / \ln\left(r/r_f \right) \qquad \textbf{(2.13)}$$

Without the correction in the second term, relative to the entire universe, the exponent ***x*** is exactly ***–2***, yielding the original Newtonian gravitational acceleration. Although this correction is extremely small for all celestial bodies, it remains significant—primarily for ontological reasons, and also because it can assume meaningful values for very large structures (clusters of galaxies) or very small structures (molecules and atoms). For these reasons, its consideration is essential.

The entire procedure applied to the Sun and Earth is summarized in the following table:

Table 2 – Determining the Exponent in the Gravitational Formula

Fund.p.	1.08862171144850E-28	3.23130882358167E-15	
name	**m [kg]**	**r [m]**	***x***
Universe	1.73944927213938E+53	1.29165299302361E+26	***-2.00000000000000***
Sun	1.98899999966466E+30	6.95500000104916E+08	***-2.00000000000005***
Earth	5.97359978608407E+24	6.37597203107029E+06	***-2.00000000000145***

- Agreement is noted with Bošković's stance that gravity is *perceptibly unchanged only within the entire planetary and cometary system*. The exponent ***x*** is practically ***-2***, confirming the accuracy of Newton's law for these systems.
- For planets, the exponent ***x*** differs from ***-2*** at the twelfth decimal place.
- The deviation of the exponent is smaller for more massive planets and the Sun.
- The deviation increases with distance.
- At large distances, ***x*** deviates significantly from ***–2***, which could explain the recession of galaxies without invoking dark energy.
- At cosmological and atomic scales, deviations from –2 indicate a deeper connection between macro- and microphysics, which Bošković anticipated with his theory of the continuous curve of force.
- Verification on small structures such as molecules, atoms, and subatomic particles requires knowledge of other forces present at those scales. As Bošković writes [1]:

121. ... Especially, in the case of extremely small distances, the whole force, which the particles exert upon one another, will differ very much in every case from the force of gravity, if that is supposed to be inversely proportional to the squares of these distances. For, in the case of gases, which exercise such a mighty force of self-expansion, there iscertainly repulsion at those very small distances from one another, & not attraction; again, the attraction that arises in cohesion is immensely greater than it ought to be according to the law of universal gravitation.

3. The planet with characteristic mass

A relation significant for planets has been derived from the logical premise that a whole and its parts are inherently dependent on each other. The objective is to demonstrate that the same reasoning can be applied to both micro- and macrophysical quantities. Using this approach, hypotheses relevant to the origin and stable development of life are proposed. The following values and formula ***(1)*** from [4] are employed:

This framework seeks to connect cosmological scales with the emergence of stable biological systems through a unified theoretical perspective. Accordingly, we begin with the formula from [4, f5]".

- Hypothetical mass quantum $m_q = 2.7233883E\text{-}69\ kg$
- Number of Planck oscillations $N = 6.3870772E+121$
- Mass of the Universe $M_u = m_q * N = 1.739449E+53\ kg$
- $q=\log_2(N)= 404.6284554$

This framework seeks to connect cosmological scales with the emergence of stable biological systems through a unified theoretical perspective. Accordingly, we begin with the formula from [4, f5].”

$$m_i = m_q * N^{1/i} \tag{3.1}$$

where m_i is a significant mass in the function of ***i*.**

For the values of ***i*** (1, 2, 3, 4, ∞) we get Mass of the Universe, the Planck mass, fundamental mass, background mass, Hypothetical mass quantum respectively [4]. In this article, I will expand the formula to refer to planets.

For cosmological structures, the following formula ***(2)*** is defined:

$$m_k = k * m_q * N^{1-1/k} \tag{3.2}$$

Apparently, the formula ***(3.2)*** we can also express in the following form:

$$m_k = k * M_u * N^{-1/k} \tag{3.3}$$

Therefore, m_i in ***(3.1)*** is the product of hypothetical mass quantum, while in ***(3.3)*** m_k is a part of the whole (the mass of the Universe).

Here ***k*** determines the form of the structure at cosmological scales. Therefore, for:

$$\mathrm{k}_0 = 4\pi/3 = 4.1887902 \tag{3.4}$$

we obtain the sphere and the related mass:

$$m_{k0} = k_0 * M_u * N^{-1/k_0} = (4\pi\ /3) * \mathrm{M_u} * \mathrm{N}^{-3/4\pi} = 6.076121 * 10^{24}\ \mathrm{kg} \tag{3.5}$$

We define m_k as the **characteristic planetary mass**, and a hypothetical planet of this mass as the **characteristic planet**.

The characteristic planetary mass m_k carries particular significance in cosmology, though its full physical implications remain to be established. Comparative analyses of the planets in the solar system can be undertaken using the above formulas, especially in relation to m_k.

It is emphasized that in equation ***(3.5)***, the value of ***k*** in both the product and exponent is identical for an ideal sphere ***(3.4)***. For real planets with mass ***m***, distinct values ***k1*** (in the product) and ***k2*** (in the exponent) must be applied.

It is further proposed that the defining property of the characteristic planet is its position at the zero-force point on Bošković's force curve [1]. This represents a state of equilibrium between the opposing processes of accretion and excretion.

The Pi factor

The inverse mass index, denoted as the Pi factor *Pf*, is defined for a planetary mass ***m*** relative to the reference characteristic planetary mass $\boldsymbol{m_k}$ as:

$$Pf = m_k/|m-m_k| \qquad \mathrm{Pf} = 1/x = m_k/|m-m_k| \tag{3.6}$$

The name "*Pi factor*" derives from the presence of the mathematical constant $\boldsymbol{\pi}$ in the formulation of ***k***.

The application of equation ***(3.6)*** to the planets of the Solar System is presented in the table below. As shown in the table, Earth's *Pi* factor greatly exceeds that of all other planets; Venus, the next highest, is smaller by a factor of 12. When planetary systems are considered, the Earth–Moon system surpasses Venus by a factor of 42, and remains significantly larger than any other.

This suggests that Earth's exceptional *Pi factor* may be a key property underlying its uniqueness and the emergence of civilization. A high *Pi factor* appears not to be the sole requirement for life, but rather a condition for long-term stability of life, enabling the slow evolutionary transition toward intelligent species while reducing the likelihood of catastrophic resets.

Table 3 – *Pi factor* of Planets and Satellites

Characteristic planet	**6.07612E+24**	$Pf = m_k/\|m-m_k\|$	$Pf = m_k/\|m+m_s-m_k\|$
Planets	**Mass (kg)**	**a**	**b**
Mercury	**3.3022E+23**	**1.06**	**1.06**
Venus	**4.8685E+24**	**5.03**	**5.03**
Earth	**5.9736E+24**	**59.27**	**209.20**
Mars	**6.4185E+23**	**1.12**	**1.12**
Jupiter	**1.8986E+27**	**0.00**	**0.00**
Saturn	**5.6846E+26**	**0.01**	**0.01**
Uranus	**8.6810E+25**	**0.08**	**0.08**
Neptune	**1.0243E+26**	**0.06**	**0.06**
Moon (Earth)	**7.3477E+22**	**1.01**	
Ganymede (Jupiter)	**1.4819E+23**	**1.02**	
Europa (Jupiter)	**4.8000E+22**	**1.01**	
Titan (Saturn)	**1.3452E+23**	**1.02**	

Equation ***(3.6)*** thus singles out Earth with only one planetary parameter—mass—without the need for complex indices of habitability. Its universality offers a simple criterion for comparing planets and estimating how many may lie near the characteristic mass m_k.

4. Cosmological limits

In almost all of my works, the quantity ***"n"*** is used to classify structures in the universe based on their mass relative to the mass of the whole universe, and we refer to it as the "***n-step***":

$$n = \log_2\left(M_u / m\right) = \log_2\left(1/m\right) \tag{4.1}$$

Then, in the section on the characteristic planet, by formula ***(3.3)***, we introduced the factor „***k***", which contains the mathematical constant ***"π"*** and thus dominantly influences the shape of the structure. Now let us introduce the factor:

$$\mathrm{i} = q / n\pi \tag{4.2}$$

which is also connected with the factor ***k*** by the expression:

$$\mathrm{i} = 2^{4-16\pi/3k} \tag{4.3}$$

Thus, k is also expressed through the known *q=log₂(N)*:

$$\mathrm{k} = \frac{16\pi}{3*\left[4+\log_2\left(q/n\pi\right)\right]} \tag{4.4}$$

In other words, the factors ***i*** and ***k*** can be expressed in terms of ***q*** and are interdependent, so we assume that together they are govern the organization of structure in the universe. Why precisely these relations and the constants within them—I will repeat from my earlier papers.

At different levels of matter organization, from the non-extended to the complex, not only do the forms of organization change, but also the mathematical operations that describe them.

Through the factor ***"i",*** we define the mass of any structure by the formula:

$$m_i = M_u * N^{-1/(\mathrm{i}*\pi)} \tag{4.5}$$

Through these factors, the universe self-adjusts to function as a self-sufficient whole.

Now, if we assume that there exists a mass limit for which $m_k = m_i$, then by equating ***(3.3)*** and ***(4.5)*** and simplifying, we obtain:

$$k * N^{1-1/k} = N^{16*\pi/3\mathrm{k}-4} \tag{4.6}$$

Rearranging gives:

$$\frac{N^{\left[1/k+1/\left(\pi * 2^{4+16\pi/3k}\right)\right]}}{k}=1 \qquad \textbf{\textit{(4.7)}}$$

From here, for a known ***N*** (see Section 3), the value of ***k*** is calculated numerically, yielding two solutions. When these values are substituted into ***(3.1)*** and ***(3.4)***, the resulting masses are shown in the table:

Table 4 – Chandrasekhar Limit

naziv	***k***	***i***	m_i	m_k	m_i / m_k
M_{ch}	**22.5061034**	**9.55018137453**	*1.51569E+49*	**1.51569E+49**	***1***
m_{ch}	**5.1816549**	**1.70107412536**	*2.80448E+30*	***2.80448E+30***	***1***

The mass m_{ch} represents the Chandrasekhar limit, while M_{ch} is its galactic analog. The largest deviation of m_k from ***m*** is associated with quasars, whose intense radiation and matter ejection cause such extremes (see continuation of the table).

quasar	**7.7814952**	**3.597**	*2.89385E+42*	***3.00798E+38***	***9620.585***

The mass M_{ch} can be defined as the mass limit of the largest fundamental gravitational subunit in the universe. The mass of the universe (M_u) and the mass of the subsystem (M_{ch}) represent limits rather than strictly defined values. Therefore, their ratio $M_u/M_{ch} = 11476.266$ does not correspond to an integer composed of identical subunits, but rather reflects a dynamic structure that fluctuates between the whole and its subunits.

Cosmological limits, as shown, represent a mathematical necessity, while all their manifestations are phenomena that naturally arise from this principle.

5. Orbital Relations of the planets in the Solar System

The Titius–Bode law was proposed in the 18th century served as an empirical formula for the distances of planets in the Solar System. Today, the law holds primarily historical significance, as it lacks a solid physical foundation and exhibits notable inaccuracies in its predictions. Nevertheless, it remains useful as an introduction to the topic of orbital elements:

$$a_n = 0.4 + 0.3 * 2^n \qquad \textbf{\textit{(5.1)}}$$

where a_n is the semi-major axis of a planet's orbit around the Sun, expressed in astronomical units (AU), and ***n*** is the ordinal number of the planet in the sequence (the first term corresponds to Mercury with $n = -\infty$, then Venus with $n = 0$, Earth with $n = 1$, Mars with $n = 2$, and so on). This law provides approximate values with errors of several percent.

For this reason, an alternative approach is presented here, using coefficients k, which represent the ratios of the planets semi-major axes relative to the reference orbits of Earth or Mars.

The results in Table 18 are also inspired by the ideas of *Theoria Philosophiae Naturalis* by Roger Joseph Boscovich [1], further emphasizing the importance of this theoretical framework in contemporary understanding of nature. The table presents the ratios of the semi-major axes of the Solar System planets, using Mars and Earth as reference points and mathematical constants related to π.

Table 5 – Planetary Orbits in the Solar System

	semi-major axis	*k*	k=	*az=k*a(Earth)*	*Rg%*
Planeta	*a [m]*	*k*	k=	*am=k*a(Mars)*	*Rg%*
Merkur	5.79092270E+10	$(1+(2\pi)^{\wedge 1/4})^{\wedge -1}$	0.387112	5.791115E+10	*0.003*
Venera	1.08209475E+11	$lg_2(lg_2(2\pi)+1)/(lg_2(3)+1)$	0.72283	1.081339E+11	*-0.070*
Zemlja	1.49598023E+11	*1*	1.0000	1.495980E+11	*0.000*
Mars	2.27943824E+11	*1*	1.0000	2.279438E+11	*0.000*
Jupiter	7.78340821E+11	$2+2^{\wedge 0.5}$ =	3.4142	7.782489E+11	*-0.012*
Saturn	1.43352698E+12	2π =	6.2832	1.432213E+12	*-0.092*
Uran	2.87524663E+12	4π =	12.5664	2.864427E+12	*-0.376*
Neptun	4.49506083E+12	$2\pi^{\wedge 2}$ =	19.7392	4.499431E+12	*0.097*
Pluton	*5.90637627E+12*	$4\pi^{\wedge 2}$ =	39.4784	5.905893E+12	*-0.008*

Analysis and implications:

1. **Accuracy for outer planets:** For the outer planets (from Jupiter onward), the k-coefficients yield values with relative errors (Rg) below 0.1%. This demonstrates the consistency of ratios based on coefficients related to π.
2. **Formula distinction:** A clear distinction between inner and outer planets.
3. **Venus:** No reference semi-major axis related to π was found that achieves the same level of accuracy, though possible connection with $log_2(3)$.
4. **Jupiter:** The ratio is associated with **2**.
5. **Saturn, Uranus, and Neptune:** These form an orderly sequence of ratios tied to π.
6. **Pluto:** Also included in Table, as it continues the sequence relative to Earth.
7. **Dichotomy of the Solar System:** The inner planets' orbits are relatively close, while the outer planets' orbits progressively widen with distance from the Sun. The k-coefficients account for this dichotomy, while orbital resonances arise as a natural consequence.

8. **Physical interpretation:** The ***k***-coefficients point to orbital resonances, which contribute to the stability of the Solar System and shape the characteristics of planetary orbits.
9. **Broader application:** The defined coefficients can be applied to analyzing orbital structures in other stellar systems, offering deeper insights.

The proposed empirical relationships for the semi-major axes of the Solar System planets provide a more precise alternative to the classical Titius–Bode law. A particular advantage of using Mars' semi-major axis as a reference is the accuracy of the results obtained, especially for the outer planets. However, for Venus, no suitable reference semi-major axis was found to achieve the same level of precision. For the distant object Pluto, Earth proved to be a more appropriate reference.

Semi-major axes, as virtual indicators, exhibit indicative mathematical relationships, which real aphelia and perihelia do not. Importantly, this is a general principle applicable to all structures—for example, in quantum physics, where virtual points are often used.

Further research could focus on:

- Application to exoplanetary systems,
- Investigating the influence of gravitational resonances on the stability of planetary orbits,
- Analyzing the effects of smaller bodies, such as satellites and asteroids, on planetary dynamics.

6. The Extended Third Kepler's Law

The squares of the orbital periods of planets around the Sun ***(T)*** are proportional to the cubes of the semi-major axes ***(a)*** of their orbits:

$$\frac{a^3}{T^2} = \mathrm{G}^*\mathrm{M}_c / 4\pi^2 \qquad (\mathbf{6.1})$$

Where:

- M_c – mass of the central body,
- G – gravitational constant.

To extend the application of the law using Boscovich's limits, we introduce the substitution $G = c^{\wedge 2} * R_u / M_u$. This yields a new formulation of the law in a dimensionless form:

$$\frac{M_c}{M_u} = 4\pi^2 * a^3 / (\mathrm{T}^2 * \mathrm{c}^2 * \mathrm{R}_u) \qquad (\mathbf{6.2})$$

Where:

- R_u – radius of the universe,
- M_u – mass of the universe,
- c – speed of light.

Since $c = R_u / T$, it follows that:

$$\frac{M_c}{M_u} = 4\pi^2 * \left(a / R_u\right)^3 / (\mathrm{T}/\mathrm{T}_u)^2 \tag{6.3}$$

Logarithmically:

$n_c = \log_2(M_c/Mu)$, $\underline{a} = \log_2(a/R_u)$, $\underline{T} = \log_2(T/T_u)$, $\underline{b} = \log_2(2\pi)$

we can express the law for Earth in logarithmic form:

(6.4)

$$\boxed{3\underline{a} - 2\underline{T} = 2\underline{b} + n_c}$$

81.5139 81.5139

Analogously, for the **proton** (intentionally without introducing the substitution $T = \underline{\bar{\lambda}}*2\pi/c$):

(6.5)

$$\boxed{3\underline{\bar{\lambda}} - 2\underline{T} = 2\underline{b} + q - n}$$

144.12068 144.12068

As shown in Section 3, $q = 404.6284554$. Thus, we observe between **(6.4)** and **(6.5)** a reflectional symmetry with respect to n — the reflection $n_c \mapsto q-n$; in other words, for elementary particles, the "central body" is represented by the expression q-n. By introducing the substitution for T, equation **(6.6)** is obtained, in which the term $2\underline{b}$ disappears, but the equality remains.

(6.6)

$$\boxed{\log_2(R_u / \bar{\lambda}_p) = q - n}$$

138.8177 138.8177

If we solve for $\bar{\lambda}_p$, we obtain:

(6.7)

$$\boxed{\bar{\lambda}_p = R_u * 2^{\wedge(n-q)}}$$

2.1030891E-16

Which is merely another way of expressing the well-known formula $\bar{\lambda}_p = \hbar/(m_p*c)$. The goal here is achieved by recognizing, through formulas ***(6.4)*** and ***(6.5)***, that in the previous expressions $\bar{\lambda}$ has actually been replaced with a, meaning that for planets orbiting a central body, the semi-major axis takes on the role of the reduced Compton wavelength (the *cohesion* limit). Ontologically speaking, when moving from the *non-extended* to the *extended*, the function of $\bar{\lambda}$ is assumed by ***'a'***.

Cosmological phenomena relate to the entirety of the universe, while the wave manifestation of particles is linked to the parameter ***q***, and consequently to the lower limits of mass and distance.

In other words, the semi-major axes of planetary orbits around the Sun embody the same principle observed in the relationship of elementary particles to their reduced Compton wavelength, as formulated by Kepler's Third Law.

By using the logarithm, Kepler's Third Law has been employed to connect the macroscopic and wave nature of particles. This enables the comparison of different systems—from planetary to subatomic—and provides insight into the universal interconnectedness of physical laws.

7. The temperature of the cosmic microwave background

In the kinetic theory of gases, collisions of gas molecules within a confined container are considered. Similarly, the Universe can be viewed as a closed system, where, instead of physical boundaries, natural laws act as a kind of "limit."

Here, we present the results, where, as before, 2π and $cy = e^{2\pi}$ are mathematical constants, while α^{-1} and μ are known physical constants. Additionally, we will use the auxiliary constants Δp and q for the sake of brevity. Also, m_{pr} and c denote the proton mass and the speed of light, respectively.

Table 7 – Input Values for Background Temperature (T_{bg})

2π, $ci = e^{2\pi}$	6.28318530718	535.491655525
$\acute{\alpha}$, μ =	137.035999084	1836.15267343
$\Delta p=2-1/(\mu/\acute{\alpha}+2)$, $q=3ci/4+3*lg_2(2\pi)/2-\Delta p/2$	1.9350609435	404.628455366
m_{pr} [kg], c [m s^{-1}]	1.67262192369E-27	299792458
k_B[$m^2kgs^{-2}K^{-1}$], T_{bg}[K] f(7.1)	1.380649E-23	2.725716715

The final formula for the temperature of the cosmic microwave background may appear complex at first glance, yet it can be routinely derived through a series of simplifications that allow for highly precise calculation:

$$T_{bg} = m_{pr} * c^2 * 2^{cy/2-\Delta p-3q/4-\lg_2\left[(2\pi)^{1/4}*(q/3)^{1/2}\right]} / k_B = 2.725716715\,K \qquad (7.1)$$

An even simpler way to reach the same result is by using the Planck temperature T_{pl} = 1,4168335*$10^{\wedge 32}$ K, which leads to the identical outcome via formula ***(7.2)***:

$$T_{bg} = 2\pi * T_{pl} * 2^{cy/2-\Delta p/3-11q/12-\lg_2((2\pi)^{1/4}*(q/3)^{1/2})} = 2.725716715\,K \qquad (7.2)$$

The process of obtaining significant temperatures is not shown, and the conclusions are as follows:

- The Planck temperature represents the upper limit of the number of simultaneous collisions in the universe.
- The temperature of the cosmic microwave background (CMB) is not a relic radiation from the past, but rather represents the geometric mean of all temperatures. It can also be interpreted as the boundary between temperatures lower than T_{bg} in the voids of the universe and higher than T_{bg} in regions containing matter.
- There is no absolute zero temperature, i.e., a complete absence of collisions or motion. Instead, all temperatures lie between the upper and lower limits, with the lower limit denoted as the hypothetical quantum of temperature T_{hq} .

$$T_{hq} = T_{bg}^2 / T_{pl} = 5.243758 * 10^{-32} K \qquad \textbf{\textit{(7.3)}}$$

The above results could be expressed even more simply if the temperature scale were set such that $T_{bg} = 1$ by definition.

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