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Jose Carlos Gomez * and Douglas Larsson Engholm

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Keywords: Fundamental constants; System of Units; Spacetime Structure; Planck Units; Dimensional analysis

Article

Structural Units: A New Unit System for Quantifying Spacetime to Unify Physics

J. C. Gómez [1,2,*] and D. Engholm [3]

1 Independent researcher, Spain
2 Research Fellow, Information Physics Institute, Gosport, Hampshire, United Kingdom
3 Independent researcher, Sweden
* Correspondence: jccazorla39@gmail.com

Abstract: Structural Units (SU) is a novel unit system, proposed as compatible to the International System of Units (SI), rooted in Spacetime Structure. Unlike SI, which evolved over history without a fixed reference frame, SU defines one Structural Unit as the space and time between two vertices in the Spacetime Structure. This perspective offers a unique viewpoint, where space and time units are proportionate. This correlation results in Natural constants being expressible through algebraic relationships involving the pure numbers π, φ (the Golden ratio), and α (the Fine Structure constant), not only simplifying Fundamental constants but also introducing a harmonious integration of geometric concepts. In contrast, SI currently relies on fixed values for seven constants derived from CODATA. It's crucial for Structural Units to seamlessly integrate with the existing International System of Units, proposing a theoretical framework, hitherto nonexistent, for the values of the various Fundamental Constants that have been experimentally obtained in our scientific endeavor. To ensure compatibility, the four Planck Units, (length, mass, time, and temperature), introduced by Max Planck in 1899, will be recalculated in SU and then converted back to SI using dimensional analysis. Additionally, to further validate this compatibility, we will examine the Schwarzschild radius from Relativity, the photon energy from Quantum Mechanics, and propose a new interpretation of the Uncertainty Principle under the SU framework. This potential harmonization of geometry and Natural constants in SU could offer a deeper understanding of the inherent order in the fabric of the Universe.

Keywords: fundamental constants; system of units; spacetime structure; planck units; dimensional analysis

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I. Introduction

When Max Planck, in 1899, at the end of his manuscript in which he defined the Planck constant [1], proposed the base units that would later bear his name, he wrote the following:

"It is possible to set up units for length, mass, time, and temperature, which are independent of special bodies or substances, necessarily retaining their meaning for all times and for all civilizations, including extraterrestrial and non-human ones, which can be called 'natural units of measure'."

With these words, Planck expressed the need to find references independent of human choices in our system of units. In the quest for a deeper understanding of these values, he selected four Universal constants G, h, c, and KB to isolate the units of length, time, mass, and temperature. After uncertain beginnings, during which many scientists deemed Planck Units absurd, it wasn't until the 1950s that they were revisited. This occurred during the early stages of the development of Quantum Relativity Theory (QRT), where their values were successively applied as different limits within the theory [2]. Within this context, we present a pioneering approach to the theory and measurement of Natural constants – Structural Units [3,4]. Inspired by the intrinsic properties of Spacetime, this innovative system of units aims to redefine the way we quantify physical

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quantities. One distinctive feature of this unitary paradigm is the departure from defining Natural constants based on experimental values regularly updated by CODATA [5]. Instead, in the Structural System of Units, these constants find definition through three pure numbers ubiquitous in Nature. This method establishes a direct link between Mathematics, Geometry, and Physics, providing a framework that transcends empirical observations. This extraordinary assertion must also be substantiated by solid evidence that can be verified, devoid of any numerical coincidence. For this reason, I have chosen the conversion of Planck Units, widely known within the scientific community, to continue testing Structural Units. While this study lacks complicated mathematics, it is essential to emphasize that this should be viewed as beneficial and useful, with the aim of de-escalate the complexity in our research and return to a path that traces back to the origins of Quantum Mechanics. Furthermore, Structural Units could play a crucial role in unifying Relativity and Quantum Mechanics. To explore this potential, we will examine one equation from each domain: the Schwarzschild radius from Relativity and the photon energy from Quantum Mechanics. Additionally, we will propose a new interpretation of the Uncertainty Principle under the SU framework, considering the concept of Spacetime quantization.

II. Methods

To carry out the translation between the two systems of units, several concepts must be considered, such as the four premises introduced in our previous published works [3,4]:

1. Spacetime is quantized into energy-linked equidistant vertices, separated by the Compton electron wavelength and time.
2. Spacetime is an omni-tensional structure with the capacity to encapsulate the energy and mass that constitute the Universe. Within this structure, atoms and photons experience quantized movement from vertex to vertex.
3. Spacetime curvature arises from an angle change between structural vertices, defining gravity as the equilibrium between the energies contained in a mass and the Spacetime that surrounds it.
4. Lastly, we propose the translatability of physical properties into what we term Structural or Spacetime Units. This suggests a proportional connection among various Natural constants, unveiling that the number α known as the Fine Structure constant [6], present in several Quantum Mechanics equations, is linked to the same Spacetime Structure.

By leveraging the geometric relationship between the energies governing a hydrogen atom, as expressed through its equations, we unveil an equivalence table between the International System of Units (SI) and the Structural System of Units (SU) [3]. This table, derived through the conversion of equations by substituting terms with their Structural Units equivalents, serves as a comprehensive guide for calculations, presenting values in both unit systems:

Table 1. Most of the Natural constants and related values presented above are expressed as functions of the numbers π, the Golden ratio φ, and the Fine Structure constant α, showcasing their close relationships. The units of meters, seconds, and kilograms in our SI have been replaced with the units of distance and time used in SU for dimensional analysis. The equivalent CODATA concise form values in SI [5] are included to streamline calculations.

NATURAL CONSTANT	*SI VALUE*	*SU VALUE*	*SI UNITS*	*SU UNITS*
h *(Planck constant)*	*6.62607015*10^{-34}*	$\frac{2}{\alpha^2}$	$\frac{kg\ m^2}{s}$	$\frac{time^3}{space^2}$
K_C *(Coulomb constant)*	*8987551793*	$\frac{2}{\alpha^2}$	$\frac{kg\ m^3}{s^2\ C^2}$	$\frac{time^2}{space\ Charge^2}$
G *(Gravitational constant)*	*6.67430(15)*10^{-11}*	$2.293211567 * 10^{-50}$	$\frac{m^3}{kg\ s^2}$	$\frac{space^7}{time^6}$

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K_B (Boltzmann constant)	1.380649*10^-23	$\frac{2\varphi \cos\omega}{\alpha^3\pi^2}$ *	$\frac{kg\ m^2}{s^2\ K}$	$\frac{time^3}{space^3}$
μ_0 (Magnetic permittivity)	1.256637062(19)*10^-6	$8\varphi^2\pi$	$\frac{kg\ m}{C^2}$	$\frac{time^4}{space^3\ Charge^2}$
ε_0 (Electrical permittivity)	8.8541878128(13)*10^-12	$\frac{\alpha^2}{8\pi}$	$\frac{s^2\ C^2}{kg\ m^3}$	$\frac{space\ Charge^2}{time^2}$
c (Speed of light)	299792458	$\frac{1}{\varphi\alpha}$	$\frac{m}{s}$	$\frac{space}{time}$
m_e (Electron rest mass)	9.1093837015(28)*10^-31	$\frac{4\varphi^2}{\alpha^2}$†	kg	$\frac{time^4}{space^4}$
m_p (Proton mass)	1.67262192369(51)*10^-27	$\frac{1}{(\cos\beta)^4\alpha^4}$ **	kg	$\frac{time^4}{space^4}$
r_h (Bohr radius)	5.29177210903(80)*10^-11	$\frac{1}{4\varphi\pi}$	m	$space$
e (Elementary charge)	1.602176634*10^-19	$\sqrt{\frac{1}{2\varphi\pi}}$	Coulomb C	$Charge$
v_e (Electron frequency)	3.289841957*10^15	1	$\frac{1}{s}$	$\frac{1}{time}$
λ_{ce} (Compton electron wavelength)	2.42631023867(73)*10^-12	$\frac{\alpha}{2\varphi}$	m	$space$
t_{ce} (Compton electron time)	8.093299792*10^-21	$\frac{\alpha^2}{2}$	s	$time$
v_e (Electron speed)	2187691.262	$\frac{1}{\varphi}$	$\frac{m}{s}$	$\frac{space}{time}$
R_h (Rydberg constant)	10973731.568160(21)	$\alpha\varphi$	$\frac{1}{m}$	$\frac{1}{space}$
r_e (Electron classic radius)	2.8179403262(13)*10^-15	$\frac{\alpha^2}{4\varphi\pi}$	m	$space$

Since the units of various physical phenomena are described in SU as relationships between space and time, for dimensional analysis in SI/SU translation, use this equivalence to find SU units:

$$\mathbf{Kg} = \frac{\mathbf{time^4}}{\mathbf{space^4}},\ \mathbf{Joule} = \frac{\mathbf{time^2}}{\mathbf{space^2}},\ \mathbf{Kelvin} = \frac{\mathbf{space}}{\mathbf{time}}.$$

† In SU the electron is described as energy, as consequence, its rest mass $\frac{4\varphi^2}{\alpha^2}\ \frac{time^4}{space^4}$ is merely a mathematical concept as mass and energy in SU has different units/dimensions ($\frac{time^4}{space^4}$ and $\frac{time^2}{space^2}$, respectively).

* Angle ω= 3.680556924 degrees in Section 8.6. of our previous paper [3] is introduced this angle linked to the Boltzmann constant and atom movement.

** Angle β= 6.225471778 degrees is due to the Euclidean/non-Euclidean correction in Spacetime Structure caused by proton presence [3].

For calculations with Structural Units:

$\boldsymbol{\varphi} = \mathbf{1.618033988749}$, α= 7.297352563*$\mathbf{10^{-3}}$ [7], π= 3.141592653589.

It is also necessary to define what one Structural Unit is, understood as the spatial and temporal separation between two vertices in the Structure of Spacetime. Following the calculations [3], it was proposed as the Compton wavelength and time of an electron.

S.I.

$$Space = \lambda_{ce} = 2.42631023867 * 10^{-12}\ m.$$

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$$Time = t_{ce} = 8.093299792 * 10^{-21}\ s.$$

One Structural Unit
Space
Spacetime vertex 1 ⟷ Spacetime vertex 2
Time
S.U.

$$Space = \lambda_{ce} = \frac{\alpha}{2\varphi} = 2.255005957 * 10^{-3}\ space.$$

$$Time = t_{ce} = \frac{\alpha^2}{2} = 2.662567722 * 10^{-5}\ time.$$

Figure 1. Spacetime quantization equivalence in SI and SU.

Results

Between 1899 and 1923, Max Planck published the concept of Planck Units eight times in his works [2]. He introduced them as a natural system of units for defining the values of length, time, temperature, and mass. This was achieved through dimensional analysis by combining the values of the four Fundamental constants (G, h, c, and KB) also known as the Gravitational constant, the Planck constant, the speed of light and the Boltzmann constant, resulting in the following CODATA values table:

Table 2. The Planck Units, introduced by Max Planck, serve as Fundamental constants in the natural system of units. They define the values of length (Planck length), mass (Planck mass), time (Planck time), and temperature (Planck temperature) based on the analysis of four Natural constants. Note that, in the table, the reduced Planck constant ħ has been replaced by ((h)⁄2π).

Name	*Equation*	*Value (SI)*
Planck length	$l_P = \sqrt{\frac{hG}{2\pi c^3}}$	$1.616255(18) * 10^{-35}\ m.$
Planck mass	$m_P = \sqrt{\frac{hc}{2\pi G}}$	$2.176434(24) * 10^{-8}\ kg.$
Planck time	$t_P = \sqrt{\frac{hG}{2\pi c^5}}$	$5.391246448 * 10^{-44}\ s.$
Planck temperature	$T_P = \sqrt{\frac{hc^5}{2\pi G K_B^2}}$	$1.416784(16) * 10^{32}\ K.$

In the forthcoming analysis, we will explore the translation of the four Planck Units—length, mass, time, and temperature—into Structural Units. Once substituted into the Structural Units framework, we will then proceed to convert these values back into the International System of Units (SI). The accompanying TABLES I and II provide the necessary equivalences for this transformative process.

1. Planck Length

For calculations, we will focus on the Planck length equation as outlined in Table II. Here, we embark on a meticulous process by substituting the value of each Fundamental constant involved with its corresponding equivalent from Table I. This substitution not only facilitates the translation into Structural Units but also sets the stage for the subsequent conversion back to the International System of Units (SI), utilizing the comprehensive equivalences provided in the attached tables:

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$$l_P = \sqrt{\frac{hG}{2\pi c^3}} = \sqrt{\frac{2*2.293211567*10^{-50}\,\alpha^3\varphi^3}{2\pi\alpha^2}} = \sqrt{\frac{2.293211567*10^{-50}\,\alpha\varphi^3}{\pi}} = 1.502142903*10^{-26}\,space. \quad (1)$$

Furthermore, as a validation step, I will explicitly list the various units for space and time involved in the equation following TABLE I. This cross-verification aims to confirm the correctness of the dimensional analysis and ensure that we obtain units of space in SU per units of meter in SI, substantiating the robustness of our conversion process.

$$l_P = \sqrt{\frac{time^3*space^7*time^3}{space^2*time^6*space^3}} = \sqrt{space^2} = space. \quad (2)$$

Lastly, we will proceed with the corresponding dimensional analysis, leveraging the known equivalences between the two unit systems shown in FIG. 1. This step aims to affirm the coherence and compatibility of the Structural Units with the International System of Units, providing a comprehensive evaluation of the translated values and their adherence to dimensional consistency.

$$1.502142903*10^{-26}\,space * \frac{2.42631023867*10^{-12}\,m.}{({}^{\alpha}/_{2\varphi}= 2.255005957*10^{-3}\,space)} = 1.616255023*10^{-35}\,m. \quad (3)$$

The translation between the two unit systems demonstrates a complete accuracy, showcasing the precision and reliability of the conversion process.

2. Planck Mass

Now we will proceed with the conversion of the Planck mass. It's worth noting that in Structural Units, the mass unit (kg) represents a configuration of 4 dimensions of Spacetime, resulting in units $({}^{time^4}/_{space^4})$, meanwhile, energy takes on a configuration of two dimensions $({}^{time^2}/_{space^2})$ [3], establishing a clear distinction between these two concepts, also manifested in its dimensional analysis. Replacing with TABLE I, TABLE II equation is rewritten by numbers as:

$$m_P = \sqrt{\frac{hc}{2\pi G}} = \sqrt{\frac{1}{\pi\alpha^3\varphi*2.293211567*10^{-50}}} = 4.69852117*10^{27}\,\frac{time^4}{space^4}. \quad (4)$$

To restore the SI unit kg., we will divide our result by a factor of $(2\alpha^{-2})^2$ applying the equivalence $kg = ({}^{s^4}/_{m^4})$. This adjustment is necessary due to the dimensional disparity outlined in the TABLE I footer between mass and energy, where the proton and the electron exhibit 4D and 2D Spacetime configurations, respectively, and explained in **Section 7** of our previous paper [3]:

$$m_P = \sqrt{\frac{time^3*space*time^6}{space^2*time*space^7}} = \sqrt{\frac{time^8}{space^8}} = \frac{time^4}{space^4} = \frac{s^4}{m^4}*\frac{1}{(2\alpha^{-2})^2} = kg. \quad (5)$$

$$4.69852117*10^{27}\,\frac{time^4}{space^4}*\frac{\left(8.093299792*10^{-21}s\right)^4}{\left({}^{\alpha^2}/_2=2.662567722*10^{-5}time\right)^4}*\frac{\left({}^{\alpha}/_{2\varphi}=2.255005957*10^{-3}space\right)^4}{(2.42631023867*10^{-12}\,m)^4} =$$
$$29.92722848\,\frac{s^4}{m^4}*\frac{1}{(2\alpha^{-2})^2} = 2.121621094*10^{-8}\,kg. \quad (6)$$

Each time the unit kg is involved in the translation from Structural Units to the International System of Units, a correction is necessary due to the Spacetime curvature induced by mass, I named it β correction. It's important to note that when referring to mass, we specifically mean the proton. Acknowledging Einstein's discovery that Spacetime follows a non-Euclidean geometry, our approach involves considering a Pythagorean theorem as an extrapolation, as detailed in our previous work [3,4].

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$$\frac{2.121621094*10^{-8}\,kg}{(\cos 6.225471778)^4} = 2.172413756*10^{-8}\,kg. \quad (7)$$

The derived value, contrasted with its SI counterpart, demonstrates an accuracy of 99.8152829%. Significantly, this precision is consistently reproduced in analogous translations involving the unit kg. [3,4], establishing a discernible and recurrent pattern in our methodology.

3. Planck Time

Now, it's the turn of the Planck time, so we will follow the same steps in substituting the values and conducting subsequent dimensional analysis.

$$t_P = \sqrt{\frac{hG}{2\pi c^5}} = \sqrt{\frac{2.293211567*10^{-50}*\varphi^5\alpha^3}{\pi}} = 1.773634874*10^{-28}\,time.$$
(8)

And once again, we will verify the consistency in the units.

$$t_P = \sqrt{\frac{time^3*space^7*time^5}{space^2*time^6*space^5}} = time. \quad (9)$$

Next, we will proceed with the conversion of time unit back to seconds. In this instance, there is no need for dimensional β correction associated with mass units, as the Planck time value displays entirely Euclidean characteristics, consistent with the behavior observed in length translations.

$$1.773634874*10^{-28}\,time * \frac{8.093299792*10^{-21}\,s}{(\alpha^2/_2 = 2.662567722*10^{-5}\,time)} = 5.391246443*10^{-44}\,s. \quad (10)$$

Achieving precision down to the last decimal.

5. Planck Temperature

Similar to the approach with the Planck mass, the conversion of Planck temperature requires the introduction of two key concepts. Firstly, temperature in Structural Units is treated as a velocity, represented as space/time relationship. This interpretation aligns logically with temperature being a measure of the average velocity acquired by a particle within a given system, directly influenced by the stored energy. In connection with Brownian motion and the kinetic theory of heat [8], an angle of Spacetime (ω) is described in Section 8.6. of our previous paper [3], which is bent to produce a distinct motion from gravitational. The Boltzmann constant is then defined as the minimum energy required to initiate this motion. With these premises introduced, we will proceed with the conversion with TABLE I values:

$$T_P = \sqrt{\frac{hc^5}{2\pi G K_B^2}} = \sqrt{\frac{\pi^3}{4*2.293211567*10^{-50}*\alpha\varphi^7(\cos\omega)^2}} = 4.002487844*10^{25}\,\frac{space}{time}. \quad (11)$$

And the verification of the units.

$$T_P = \sqrt{\frac{time^3*space^5*time^6*space^6}{space^2*time^5*space^7*time^6}} = \sqrt{\frac{space^2}{time^2}} = \frac{space}{time}. \quad (12)$$

Under the point of view of describing physical phenomena through Spacetime relationships, temperature is conceptualized as a dynamic measure represented in the units of space per time. This unique perspective, harmonizing with the broader framework of Structural Units, unveils an intricate connection between temperature and the fundamental fabric of Spacetime. So, we can now proceed with dimensional analysis to return this value to our International System of Units.

$$4.002487844 * 10^{25}\ \frac{space}{time} * \frac{2.42631023837*10^{-12}\ m}{\left(\alpha/_{2\varphi}=2.255005957*10^{-3} space\right)} * \frac{\left(\alpha^2/_2=2.662567722*10^{-5} time\right)}{8.093299792*10^{-21}\ s} = 1.416784164 * 10^{32}\ \frac{m}{s} = K. \quad (13)$$

The dimensional analysis of Planck temperature, aimed at reverting Structural Units to the International System of Units, has once again yielded full precision. This consistency reinforces the robustness and reliability of our methodology. The repeated pattern of achieving such high accuracy underscores the coherence of our approach and provides compelling evidence for the compatibility between SU and SI.

III. Discussion

As explained in [9,10], during the 26th meeting of the General Conference of Weights and Measures (CGPM) in November 2018, the International System of Units (SI) underwent a transformation into a unit system based on the exact values of seven Fundamental constants: the ground-state hyperfine transition frequency of the cesium-133 atom, the speed of light, Planck's constant, elementary charge, Boltzmann's constant, Avogadro's number, and the luminous efficacy of monochromatic radiation at a frequency of $540*10^{12}$ Hertz. These constants were utilized to define the seven base units: second, meter, kilogram, ampere, kelvin, mole, and candela. This achievement was made possible only when the experimental determinations of Planck's constant, elementary charge, Boltzmann's constant, and Avogadro's number provided exact values [11]. The International Committee for Weights and Measures (CIPM) accepted the values recommended by the Task Group on Fundamental Constants (CODATA) in October 2017. Since the irrational numbers π and φ can be calculated with any desired precision, dependent only on the number of decimals chosen, the uncertainty in TABLE I, excluding the Gravitational constant, depends solely on the experimental data obtained for the Fine-structure constant (α^{-1}= 137.035999206(11)), which was calculated in 2020 [7] with a precision of 81 parts per million, significantly reducing the uncertainty in calculations that utilize it. As an example, this value leads to a precision of eleven digits in the electron g-2 factor [12], the best prediction made by the standard model, as consequence, improving this experimental value will increase the precision of this study.Taking a significant leap in Metrology, the use of pure numbers to ascertain Fundamental constants in SU establishes a connection between them. This connection, previously concealed within our unit system, is unveiled by defining space and time units as proportionate within the Spacetime Structure. This approach provides a theoretical framework for the various experimental values obtained, thereby enriching our understanding in the knowledge of this field.

This relationship directly links our Physics with Mathematics and Geometry, forging a complementary and bidirectional bridge between Structural Units and the established International System of Units (SI), where Natural constants can be determined independently of any experiment, linking with a theoretical framework independent of human conventions with a solid explanation of why they acquire that precise value. In this way, the following table of equivalences can be presented:

Table 3. The Structural Unit equations are obtained through the proposed paradigm shift, translating the Planck Units to Structural Units. The precision achieved dismisses any numerical coincidence, the dimensional analysis yields result with exceptional accuracy, indicating full alignment between both systems of units.

Name	*Equation*	*Value (SI)*	*Equation in SU*	*From SU to SI value*
Planck length	$l_P = \sqrt{\frac{hG}{2\pi c^3}}$	$1.616255(18) * 10^{-35}\ m.$	$l_P = \sqrt{\frac{2.293211567 * 10^{-50} * \alpha\varphi^3}{\pi}}$	$1.616255025 * 10^{-35}\ m.$

Planck mass	$m_P = \sqrt{\frac{hc}{2\pi G}}$	$2.176434(24) * 10^{-8}\ kg.$	$m_P = \sqrt{\frac{1}{2.293211567 * 10^{-50} * \pi\alpha^3\varphi}}$	$2.172413754 * 10^{-8}\ kg.$
Planck time	$t_P = \sqrt{\frac{hG}{2\pi c^5}}$	$5.39124644 * 10^{-44}\ s.$	$t_P = \sqrt{\frac{2.293211567 * 10^{-50} * \varphi^5\alpha^3}{\pi}}$	$5.391246443 * 10^{-44}\ s.$
Planck temperature	$T_P = \sqrt{\frac{hc^5}{2\pi G K_B^2}}$	$1.416784(16) * 10^{32}\ K.$	$T_P = \sqrt{\frac{\pi^3}{4 * 2.293211567 * 10^{-50} * \alpha\varphi^7(\cos \alpha}}$	$1.416784164 * 10^{32}\ K.$

IV. The Gravitational Constant

As mentioned earlier, the Gravitational constant (G) presents the highest level of uncertainty among all experimental measurements of the various Fundamental constants, making it a current subject of study [13]. In the following, we will address this issue from the perspective of Structural Units. Firstly, it should be noted that the unit of mass (kg.) plays a role in G, introducing a non-Euclidean component into the experimental result. As explained in the deduction of Structural Units, this effect is precisely calculated through the Euclidean calculation of the Spacetime angle that bends a proton. This extrapolation can be accurately deduced by isolating it in the dimensional analyses between SI and SU in the Natural constants where the unit kg. is involved [3], following this expression or the inverse, if the unit of mass is in the numerator, instead of the denominator as in G:

$$\frac{G_{CODATA}}{G_{From\ SI\ to\ SU}} * 100\% = \frac{1}{4 * m_p * \alpha^4 \varphi^4 * (\cos \beta)^8 * c^4} * 100\% = 99.815267\ \%. \quad (14)$$

This extrapolation factor between Euclidean and non-Euclidean geometries will have an uncertainty that depends solely on the experimental values of the proton mass and the Fine Structure constant, two of which yield high precision in their measurement. Thus, their repetition in different translations between SI and SU, where the mass unit appears, should be considered evidence of their accuracy [3]. Now, to address the current problem leading to increased uncertainty in the measurement of G from the perspective of Structural Units, we will focus on the intrinsic characteristics of this Natural constant. To do this, we will introduce an equation obtained in our previous work [3]:

$$G = \frac{c^3 T}{6 M_v} \quad (15)$$

Where T is the Cosmic age and M_v the Quantum Vacuum mass. Unlike the rest of the Fundamental constants, G would be a non-local property of Spacetime. While the others determine a value localized in a specific area of the Structure, determining the value of G involves data extraction from the broader Spacetime Structure, extending over a significantly larger radius from the experiment's location. Hence, the curvature of the surrounding Spacetime itself would influence the precision of the measurement. This hypothesis could be experimentally tested by determining the values of G, considering the different orbital positions of our satellite the Moon, concerning the experiment's location. This aims to ascertain whether such considerations reduce the uncertainty among the various experimental values obtained, because if confirmed, this point could lead to an increased precision in the measurement, especially when considering the positions of other celestial bodies in order of influence on Earth's orbit.

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V. New Perspectives for Fundamental Constants Determination

The geometric and mathematical framework of Structural Units may enable more precise calculations of Fundamental constants and their relationships. This could lead to improved accuracy in experimental measurements and theoretical predictions. The existence of hybrid equations that interconnect both unit systems not only allow for verifying the complete compatibility between the two systems but also comparing experimental results with the predictions made by the theoretical framework. Next, I introduce the following hybrid equation predicting the proportional relationship between the mass ratio of a proton and an electron:

$$\varphi^2 = \frac{m_e}{4m_p\alpha^2(\cos\beta)^4} \qquad (16)$$

In the first term of the equation (16), we encounter the theoretical and predictive aspect.

Since φ is an irrational number, its decimals can be known to the desired precision. In the second term, we find the experimental part composed of the ratio between the mass of the proton and the electron, the Fine Structure constant (α), and β, defined as the Spacetime angle bent by a proton, directly dependent on the value of α and repeatedly used in the dimensional analysis between SI and SU, where the unit of mass kg is involved. We will now conduct the following mathematical experiment: we will perform three iterations, solely changing the number of decimals in the predictive part, to observe if the calculated value tends toward the experimental result. To facilitate this experiment, we will rearrange the equation, considering the CODATA value of the proton-to-electron mass ratio as the target.

$$1836.15267343 = \frac{m_p}{m_e} = \frac{1}{4\varphi^2\alpha^2(\cos\beta)^4} \qquad (17)$$

Except for φ, the values for the rest of the equation will be those presented in TABLE I and its footnote, yielding the following results.

Table 4. In the first column, the value of φ used is presented, while the second column displays the result of Eq. (17) when inserting that value.

φ	m_p/m_e
1.61803	1836.16172636821
1.618033988	1836.15267513196
1.61803398874989	1836.15267343

Thus, it can be observed that a greater number of decimals in the prediction results in a closer approximation, eventually matching the best experimental value obtained to date. This also eliminates any possibility of an arbitrary relationship.

VI. Structural Units: A New Tool

To conclude this article, we will choose one equation from Relativity and another from Quantum Mechanics, repeating the conversion process between the International System of Units (SI) and Structural Units (SU) used for the Planck units. Additionally, I will attempt to explain how the Uncertainty Principle can be integrated within this new context.

1. Schwarzschild Radius

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The Schwarzschild radius is a fundamental concept in General Relativity, representing the radius at which the escape velocity from a spherically symmetric mass equals the speed of light. This critical radius defines the event horizon of a black hole, beyond which nothing, not even light, can escape. The equation for the Schwarzschild radius was derived by Karl Schwarzschild in 1916 [14], shortly after Einstein published his general theory of relativity. It has since become a cornerstone in the study of black holes and spacetime curvature. By converting this equation from the International System of Units (SI) to Structural Units, we aim to demonstrate the compatibility of SU with general relativity and provide insights into the geometric nature of spacetime as proposed by SU. To simplify I will choose the Schwarzschild radius (r_S) of a proton using again the values of Table I:

$$r_S = \frac{2Gm_p}{c^2} \qquad (18)$$

Where G is the Gravitational constant, m_p the proton mass and c the speed of light.
SI (CODATA):

$$G = 6.6740 * 10^{-11} \frac{m^3}{kg\, s^2}.$$

$$m_p = 1.67262192369 * 10^{-27}\, kg.$$

$$c = 299792458 \frac{m}{s}.$$

Performing the calculations:

$$r_S = 2.484231694 * 10^{-54}\, m.$$

SU (Table I VALUES):

$$G = 2.293211567 * 10^{-50} \frac{space^7}{time^6}.$$

$$m_p = \frac{1}{(\cos\beta)^4 \alpha^4} = 361088288.4 \frac{time^4}{space^4}.$$

$$c = \frac{1}{\varphi\, \alpha} = 84.69290523 \frac{space}{time}.$$

By substitution in equation (18):

$$r_S = 2.308837993 * 10^{-45}\, space.$$

Now we will proceed with the conversion from SU to SI following the proposed spacetime quantization equivalence in the dimensional analysis:

$$r_s = 2.308837993 * 10^{-45}\, space * \frac{2.42631023867 * 10^{-12}\, meters}{\left({}^{\alpha}/_{2\varphi} = 2.255005957 * 10^{-3} space\right)} = 2.48423169 * 10^{-54}\, m. \qquad (19)$$

With exact values, the compatibility between both systems of units is once again verified

2. Photon Energy

The relationship between a photon's energy and its frequency is a cornerstone of quantum mechanics, encapsulated in the Planck-Einstein relation *E=hν (1)*. This fundamental equation, derived by Max Planck in 1900, revolutionized our understanding of energy quantization and marked the inception of quantum theory. Planck's hypothesis that energy is quantized was initially proposed to resolve the ultraviolet catastrophe in black-body radiation, leading to the discrete energy levels that are now fundamental to quantum mechanics. This time we will use the electron frequency (ν_e) to make calculations easier:

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$$E = h\nu_e \qquad (20)$$

SI (CODATA):

$$h = 6.62607015 * 10^{-34} \frac{kg\ m^2}{s}.$$

$$\nu_e = 3.289841957 * 10^{15} \frac{1}{s}.$$

Therefore equation (20) equals to:

$$E = 2.179872359 * 10^{-18} \frac{kg\ m^2}{s^2} = Joules.$$

SU (TABLE I VALUES):

$$h = \frac{2}{\alpha^2} \frac{time^3}{space^2}.$$

$$\nu_e = 1 \frac{1}{time}.$$

As consequence:

$$E = \frac{2}{\alpha^2} \frac{time^2}{space^2}.$$

Applying the corresponding dimensional analysis:

$$E = \frac{2}{\alpha^2} \frac{time^2}{space^2} * \frac{(8.093299792 * 10^{-21})^2\ seconds^2}{\left({\alpha^2}/{2} = 2.662567722 * 10^{-5}\right)^2\ time^2} * \frac{\left({\alpha}/{2\varphi} = 2.255005957 * 10^{-3}\right)^2\ space^2}{(2.42631023867 * 10^{-12})^2\ meters^2} =$$

$$2.997450314 * 10^{-9} \frac{seconds^2}{meters^2}. \qquad (21)$$

Now, we must transform the energy units of space and time to our International System of Units (SI), where energy is expressed in Joules. As indicated in the section on Planck mass, there is a dimensional difference between mass and energy, with mass and energy being 4D and 2D spacetime structures, respectively. Following the same reasoning, we will divide by the same dimensional correction factor to obtain the mass unit in kilograms (kg) from SU.

$$2.997450314 * 10^{-9} \frac{seconds^2}{meters^2} * \frac{1}{(2\alpha^{-2})^2} \left(kg = \frac{seconds^4}{meters^4} \right) = 2.124972521 * 10^{-18} \frac{kg\ s^2}{m^2} = Joules.$$

(22)

As the final step in transforming the Planck equation from SU to SI, we will apply the β correction described in the section on Planck mass. This correction is attributed to the non-Euclidean geometry of curved spacetime. Additionally, we will verify that the extrapolation is accurate when the unit of mass (kg) in our SI system is present in the described physical quantity.

$$\frac{2.124972521 * 10^{-18} \frac{kg\ s^2}{m^2}}{(\cos 6.225471778)^4} =$$

$$2.175845418 * 10^{-18}\ Joules. \qquad (23)$$

The accuracy of the translation is given by:

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$$\frac{2.175845418 * 10^{-18}\,Joules}{2.179872359 * 10^{-18}\,Joules} * 100\%$$

$$= 99.8152671\%.$$

Just the same percent found in previous calculations, due to Euclidean/non-Euclidean extrapolation as also it is explained in Gravitational constant section.

3. Uncertainty Principle

In Quantum Mechanics, the Uncertainty Principle, formulated by Werner Heisenberg in 1927 [15], asserts that the more precisely one property (such as the position) of a particle is known, the less precisely another property (such as momentum) can be known. This principle is a direct consequence of the wave-particle duality of matter and fundamentally challenges the classical idea of precise measurements. Mathematically, the Uncertainty Principle is expressed as:

$$\Delta x * \Delta p \geq \frac{\hbar}{2} \qquad (24)$$

Where Δx is the uncertainty in position, Δp is the uncertainty in momentum, and $\hbar$ (*h-bar*) is the reduced Planck constant, defined as $\hbar = h/2\pi$. Under the Structural Units framework, the concept of Spacetime being quantized into energy-linked equidistant vertices offers a novel way to interpret the Uncertainty Principle. In SU, Spacetime is viewed as a grid of discrete points or vertices, separated by the Compton wavelength and corresponding time intervals, this quantization implies that there is a minimum measurable distance and time, which aligns with the concept of minimum quantum units. In SU, the Planck constant *(h)* is considered the minimum quantum unit of Spacetime shear viscosity, as we deduce in the equation (114) of our previous manuscript [3], combining our formulas with the one obtained by Kovtun, Son and Starinets in 2004 to describe a universal value between the viscosity of a fluid and volume density *(S)* of entropy in quantum field theories $({}^{\eta}/_{S} = {}^{h}/_{8\pi^2 K_B})$ [16] *(K_B= Boltzmann constant)*:

$$h = \frac{4\eta}{N_u} \qquad (25)$$

Where η is the total Spacetime shear viscosity and N_u the number of energy vertices that forms the Structure. The uncertainty in position *(Δx)* and momentum *(Δp)* could be seen as a reflection of the discrete nature of Spacetime vertices and the energy transitions between them. The relationship between shear viscosity *(η)* and the Planck constant suggests that energy transitions are governed by the same properties of the Spacetime Structure, since η is proportional to the number of energy vertices *(Nu)*, being h its minimum shear viscosity, also it can be inferred that any measurement is limited by the discrete steps in the Spacetime grid. Introducing these concepts, the Uncertainty Principle can be reformulated to reflect the discrete nature of Spacetime:

$$\Delta x * \Delta p \geq \frac{\eta}{\pi N_u} \qquad (26)$$

This equation emphasizes that the uncertainties in position and momentum are fundamentally limited by the quantized structure of Spacetime.

4. The Boltzmann Constant and the Uncertainty Principle

Once we have obtained an expression that relates the Uncertainty Principle to the Structure of Spacetime, we can use the found equations to search for new connections and meanings. In our previous paper [3], we also derived another formula that determines the variation of the Structure's viscosity as a function of the Universe's expansion:

$$\eta = \frac{c^3 r_U^2}{16G} \qquad (27)$$

Where η is the Spacetime shear viscosity, ru the Universe radius and G the Gravitational constant. To put the numbers, we will establish the Compton electron wavelength as the Universe radius in eq. (27) to calculate the Spacetime shear viscosity:

$$\eta = \frac{c^3 \lambda_{ce}^2}{16G} = 1.485350901 * 10^{11}\ \frac{kg\ m^2}{s} \qquad (28)$$

With this result, we will calculate the number of structural vertices by solving Nu in the equation (25):

$$N_u = \frac{4\eta}{h} = 8.9667079721 * 10^{44}\ vertices \qquad (29)$$

Therefore, we can check the consistency of the calculations by substitution in eq. (26).

$$\Delta x * \Delta p \geq \frac{1.485350901 * 10^{11}\ \frac{kg\ m^2}{s}}{\pi * 8.9667079721 * 10^{44}\ vertices} = \frac{\hbar}{2} \quad (30)$$

Now we can rewrite the Uncertainty Principle under the framework established by Structural Units by substituting the minimum displacement with the distance between structural vertices, defined by the Compton wavelength of an electron, and the mass in the momentum term with the mass of a proton, we set these as an equality. This allows us to define the minimum distance and momentum in terms of the Structure of Spacetime, as a direct consequence of its geometry:

$$\Delta x * \Delta p = \lambda_{ce} * m_p v_m = \frac{\eta}{\pi N_u} \qquad (31)$$

We clear up the only unknown term (v_m):

$$v_m = \frac{\eta}{\pi N_u \lambda_{ce} m_p} = 12992.77896\ \frac{m}{s} \qquad (32)$$

And now we will focus on the value obtained for the momentum quantum to try to unveil its whole meaning.

$$m_p v_m = 2.173200693 * 10^{-23}\ \frac{kg\ m}{s} \qquad (33)$$

By taking a closer look, we can see that it`s possible to transform this value into the Boltzmann constant following the expression:

$$\frac{2 m_p v_m \cos\omega}{\pi} = 1.380649 * 10^{-23}\ \frac{kg\ m}{s} \qquad (34)$$

Three concepts related to SU has to be considered to fully explain this newfound relationship, being the units the first one, as I described in [3] the unit of temperature *Kelvin (k)* took the meaning of a speed $({}^{m}/_{s})$, therefore the units of the Boltzmann constant can be rewrite as:

$$K_B = \frac{kg\ m^2}{s^2\ K} = \frac{kg\ m^2\ s}{s^2\ m} = \frac{kg\ m}{s} \qquad (35)$$

The same units obtained in eq. (34).

The second one is the term $\cos\omega$, it was introduced in our manuscript [3] where the angle ω is the Spacetime angle bended when an energy equivalent to the Boltzmann constant is added to initiate particle/brownian motion, directly associated with minimal acceleration, similarly as the angle β is introduced when the unit of mass is involved, linked to gravitational acceleration. This research line connects thermodynamics with the Spacetime Structure and Non-Euclidean geometry, illustrating the relationship between energy, mass, and Spacetime.

And the third one is the introduction of π within this Structural Units framework, π's importance stems from its intrinsic connection to the geometric, periodic, and fundamental aspects of physical

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laws. It ensures that these laws remain consistent and accurately describe the relationships and behaviors of particles and spacetime, regardless of the quantization introduced by SU.

With the information presented above, we are now able to express the Uncertainty Principle in three distinct ways:

$$\Delta x * \Delta p \geq \frac{\hbar}{2} \qquad (24)$$

$$\Delta x * \Delta p \geq \frac{\eta}{\pi N_u} \qquad (26)$$

$$\Delta x * \Delta p \geq \frac{\lambda_{ce} K_B \pi}{2 \cos \omega} \qquad (36)$$

As conclusion, reformulating the Uncertainty Principle in the SU framework and including the Boltzmann constant is a promising avenue for experimental research. It can lead to a more unified theory that encompasses both quantum mechanics and thermodynamics, providing a deeper understanding of the underlying structure of spacetime and its influence on physical phenomena. This integration is important as it bridges the gap between different scales of physical laws, contributing to the ongoing quest for a unified theory of physics.

VII. Conclusions

Structural Units provide a theoretical framework for the experimental values of Fundamental constants, serving as a milestone in our exploration of a novel approach to measurement. The seamless translation between Structural Units and the Planck Units within the International System of Units marks a remarkable accomplishment. The attained precision across Planck length, mass, time, and temperature underscores the robustness of Structural Units. The conceptualization of temperature as velocity, aligned with Spacetime relationships, showcases the paradigm's versatility and elegance. The consistent high accuracy highlights the compatibility between Structural Units and the International System of Units, pointing towards a potential transformative shift in our understanding of fundamental measurements, as the suggested consideration in the experimental determination of the Gravitational constant.

Furthermore, this translation sheds new light on the behavior of Fundamental constants, subject to continuous studies [17], revealing algebraic relationships between π, φ, and α within the framework of Structural Units. This not only offers an intriguing perspective on the inherent structure of the Universe but also suggests potential avenues for further exploration into the nature of these constants.

Structural Units (SU) can become a powerful tool that could bridge the gap between Quantum Mechanics and Relativity by providing a common, quantized structure of Spacetime. Here's how SU could help reconcile these two fundamental theories:

Unified Framework:

Quantized Spacetime: SU proposes that Spacetime is quantized into equidistant vertices, which can help integrate the discrete nature of Quantum Mechanics with the continuous nature of General Relativity.

Consistent Units: By defining units through pure numbers and geometric relationships, SU creates a consistent and universal basis for measurement that is compatible with both theories.

Geometric Interpretation:

- Spacetime Structure: SU defines space and time units based on the geometry of Spacetime, aligning with the geometric interpretation of gravity in General Relativity.

- Fundamental Constants: SU expresses Natural constants through algebraic relationships involving π, φ, and α, providing a geometric perspective that could unify the constants used in both Quantum Mechanics and Relativity.

Dimensional Analysis:

- Planck Units Translation: SU translates Planck Units (length, mass, time, temperature) into its own system and then back to SI using dimensional analysis. This process highlights the inherent connections between fundamental constants and their geometric origins, potentially offering insights into how Quantum Mechanics and Relativity can be reconciled.
- Proportional Relationships: SU suggests proportional connections among various Natural constants, unveiling potential pathways to integrate the principles of Quantum Mechanics (which deals with small scales) and Relativity (which deals with large scales).

Experimental Validation:

- CODATA Compatibility: SU uses precise experimental values from CODATA for calculations, ensuring that its theoretical framework is grounded in empirical data.
- Experimental Constants: By providing a theoretical framework for experimentally determined constants, SU could guide new experiments aimed at testing the compatibility of Quantum Mechanics and Relativity. In addition, the measuring instruments can be calibrated according to Structural Units (SU), and their experimental values should match our International System of Units (SI) after applying the appropriate dimensional analysis.

Simplification and Elegance:

- Reduction of Complexity: SU aims to de-escalate the complexity in our understanding of Fundamental constants, potentially simplifying the integration of Quantum Mechanics and Relativity.
- Harmonization: The harmonization of geometric concepts and Natural constants in SU offers a more unified and elegant approach, which could be key to developing a theory of Quantum Gravity.

Uncertainty Principle:

- In this study, we have successfully expressed the Uncertainty Principle within the framework of Structural Units (SU), revealing new dimensions of its foundational role in the quantization of spacetime. By redefining the minimum displacement as the Compton wavelength of an electron, we establish a novel perspective that aligns with the intrinsic Structure of Spacetime.
- Furthermore, the introduction of the Boltzmann constant into this framework bridges thermodynamics and the Structure of Spacetime. The relationship discovered, where momentum can be represented as the Boltzmann constant multiplied by π and divided by 2, adds a thermodynamic dimension to the Uncertainty Principle. This connection not only reinforces the structural coherence of SU but also suggests deeper implications for the interplay between quantum mechanics and thermodynamics.
- These insights demonstrate the potential of Structural Units to unify diverse physical constants and principles, offering a more integrated understanding of the Universe's fundamental nature.

In summary, Structural Units provide a quantized, geometric framework that aligns with Quantum Mechanics and Relativity, potentially offering a new path to reconcile these two foundational theories through consistent units, geometric interpretation, and empirical validation.

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