# New Large Number Hypothesis of the universe

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**Abstract**

From the dimensionless unification of the fundamental interactions we will discover a new simple Large Number Hypothesis which calculates the Mass,the Age and the Radius of the universe. The diameter of the observable universe will be calculated to be equal to the ratio of electric force to gravitational force between electron and proton on the reduced Compton wavelength of the electron $2 \cdot R_U = N_1 \cdot ƛ_c$.

**Keywords**

Large Number Hypothesis , Dimensionless unification of the fundamental interactions , Fine-structure constant , Proton to electron mass ratio , Dimensionless physical constants , Coupling constant , Gravitational constant , Avogadro's number , Fundamental Interactions , Cosmological parameters , Cosmological constant , Poincaré dodecahedral space

## 1. Introduction

By the early 1930s, the unsuccessful program of unified theories had withered under the impact of quantum theory. No one was more decisive in proclaiming the end of the era than Weyl himself. Einstein paid attention to Friedman's achievements. It is very more surprising that, in 1931, Weyl failed to notice a new stage in the development of relativistic cosmology. As a mathematician, Weyl could ignore developments in astrophysics. However, there was a deeper reason for his neglect. Weyl tried, in 1919, to connect the unified theory with physical reality. He was the first to pay attention to the empirical fact of the "coincidence of large numbers", which he saw as a connection between cosmology and microphysics. He abandoned the project, but the result he obtained survived and took on a life of its own. The grand idea of possible connections between cosmology and microphysics fascinated Eddington and drew Dirac's interest. The material presented can be seen as a logical continuation and development of Dirac and Eddington's (LNH) large number hypothesis. From 1929 until his death in 1944, Arthur Eddington worked to develop an ambitious theory of fundamental physics for the theory of everything in the physical world. His incomplete theory included abstract mathematics but was difficult for other scientists to understand. The constants of nature were of particular importance to his work. Although highly original, Arthur Eddington's effort provided ideas for other British physicists, including P. Dirac and E. A. Milne. However, Eddington's work was a major failure and was rejected by the great majority of physicists. An important reason was the unorthodox view of quantum mechanics. Arthur Eddington developed a standard model of the internal structure of stars and was the first to propose nuclear reactions as the main source of stellar energy. In 1919 he rose to fame when, together with Frank Dyson, they confirmed Einstein's prediction of the bending star around the Sun. Six years later he proposed the general theory of relativity in white dwarfs, and in 1930 he developed one of the first relativistic models of the expanding universe known as the Lemaître-Edd modelington. Dirac's cosmological theory based on the G(t) hypothesis was directly inspired by the ideas of Milne and Eddington. His more general view of fundamental physics involved the assertion of a predetermined harmony between mathematics and physics. By the late 1930s Dirac had concluded that physics and mathematics would eventually merge into a single branch of higher knowledge. Although Eddington's work had elements in common with the ideas of Milne and other physicists of the period, it was unique in the way he interpreted it philosophically. Eddington was convinced that the laws of nature were subjective and not objective. Laws, he argued, were not abstract expressions of an external world, but essentially constructs of physics. This also applies to the fundamental constants of nature. Eddington's numerological and philosophical approach to fundamental physics attracted much attention among British scientists and philosophers. The general attitude was critical and sometimes dismissive.

Paul Dirac (1902–1984) was one of the greatest physicists of the twentieth century. Dirac's contribution to the early stages of quantum theory was enormous. The equation that bears his name describes the behavior of particles with half-integer spin, like electrons, and predicts the existence of antimatter. This equation is compatible with the special theory of relativity, in contrast to the corresponding Schrödinger equation that applies to particles moving at non-relativistic speeds. He was awarded the Nobel Prize in Physics in 1933 (together with Erwin Schrödinger). Dirac was the first to succeed in putting the formalism of quantum physics, which was formulated by physicists such as Heisenberg and Schrödinger, on a mathematically transparent and therefore easy-to-use basis. His book "The "Principles of Quantum Mechanics" was so groundbreaking that almost all of his colleagues had nothing but praise for this publication. However, Dirac was often questioned. Many of his assumptions later proved untenable. Perhaps it takes imaginative thinking to come up with ideas that no one else has. It may look like success: it is built on trial and error, successes and failures, but in the end, the outside world perceives only success. The rocky road to success is usually hidden. Dirac's successes overshadowed his failures, but maybe it was just the strategy he needed to show success. The Dirac Large Number Hypothesis (LNH) is an observation that he made by Paul Dirac in 1937 relating the ratios of size scales in the Universe to those of force scales. The ratios are very large dimensionless numbers, about 40 orders of magnitude at the present cosmological epoch. The Dirac Large Number Hypothesis (LNH) is a coincidence attributed to an explanation then applied as an axiom. His LNH was highly questionable. There were few colleagues who took it seriously. Dirac's theory has inspired and continues to inspire significant scientific research in various disciplines. Within geophysics, for example, Edward Teller appeared to raise a serious objection to LNH in 1948 when he argued that fluctuations in the force of gravity were inconsistent with the paleontological data. However, George Gamow demonstrated in 1962 how a simple revision of the parameters (in this case, the age of the solar system) can invalidate Teller's conclusions. The debate is further complicated by the choice of LNH cosmologies. 1978, G. Blake argued that paleontological data are consistent with the "multiplicative" scenario but not with the "additive" scenario. Arguments both for and against the LNH are also made from astrophysical considerations. For example, D. Falik argued that the LNH is not consistent with experimental results for the microwave background radiation, whereas Canuto and Hsieh argued that it is. An argument that generated considerable controversy was put forward by Robert Dicke in 1961. Known as the human coincidence or the beautiful, simply states that the large numbers in the LNH are a necessary coincidence for intelligent beings, since they parameterize the fusion of hydrogen in stars, and thus carbon-based life would not have arisen otherwise.

The anthropocentric approach to the "coincidence of large numbers" originated in two papers published by Robert Dicke in 1957 and 1961. Dicke's theoretical ideas were far from consistent. He expressed doubts that the theory had a reliable experimental basis. Dicke suggested, as a consequence of his approach, that the constants of these interactions depended on time and space. He tried to formulate a new theory of gravity which he saw as a manifestation of electromagnetism with variable permeability of vacuum. Dicke believed that the "coincidence of large numbers" was certain proof that the gravitational constant changed with time. Discussing the variability of physical constants, Dicke insisted that "the age of the Universe is not random. Various authors have introduced new sets of numbers into the original 'coincidence' considered by Dirac and his contemporaries thus expanding or distancing from Dirac's own conclusions. Jordan (1947) noted that the mass ratio for a typical star (specifically, a star of Chandrasekhar mass, itself a constant of nature, about 1.44 solar masses) and an electron approaches $10^{60}$, an interesting variation on the $10^{40}$ and $10^{80}$ usually associated with Dirac and Eddington respectively. Several authors have recently identified and speculated on the importance of an even larger number, about 120 orders of magnitude. This is for example the reason for the theoretical and observational estimates of the vacuum energy density that Nottale (1993) and Matthews (1997) linked to an LNH frame with a scaling law for the cosmological constant.

The concept of a different cosmology G first appears in the work of Edward Arthur Milne a few years before Dirac formulated LNH. Milne was inspired not by a large number of coincidences but by a contradiction of Einstein's general theory of relativity. For Milne, the space was not a structured object but merely a frame of reference in which relations such as this could accommodate Einstein's conclusions:

$$G = \frac{c^3}{\mathrm{M}_U} T_U$$

According to this relationship, G increases with time. Dirac hypothesized that the constant of universal attraction G varies with time. Dirac's hypothesis went so far as to claim that such coincidences could be explained if the very physical constants changed with $T_U$, especially the gravitational constant G, which must decrease with time:

$$G \approx \frac{1}{t}$$

However, according to general relativity, G must also be constant over time. Although George Gamow noted that such a time variation is not necessarily due to Dirac's assumptions, no corresponding change of G has been found. According to general relativity, G is constant, otherwise the law of conservation of energy is violated. Dirac dealt with this difficulty by introducing into the Einstein field equations a gauge function β that describes the structure of spacetime in terms of a ratio of gravitational and electromagnetic units [1]. In [2] we presented exact and approximate expressions between the Archimedes constant π,the golden ratio φ,the Euler's number e and the imaginary number i. New interpretation and very accurate values of the fine-structure constant has been discovered in terms of the Archimedes constant and the golden radio. We propose in [3] , [4] and [5] the exact formula for the fine-structure constant α with the golden angle,the relativity factor and the fifth power of the golden mean:

$$\alpha^{-1}=360\cdot\varphi^{-2}-2\cdot\varphi^{-3}+(3\cdot\varphi)^{-5}=137.035999164... \qquad (1)$$

Also we propose in [5] , [6] and [7] a simple and accurate expression for the fine-structure constant α in terms of the Archimedes constant π:

$$\alpha^{-1}=2\cdot3\cdot11\cdot41\cdot43^{-1}\cdot\pi\cdot\ln2=137.035999078... \qquad (2)$$

We propose in [8] the exact mathematical expressions for the proton to electron mass ratio μ:

$$\mu^{32}=\varphi^{-42}\cdot F_5^{160}\cdot L_5^{47}\cdot L_{19}^{40/19} \Rightarrow \mu=1836.15267343... \qquad (3)$$

$$7\cdot\mu^{3}=165^{3}\cdot\ln^{11}10 \Rightarrow \mu=1836.15267392... \qquad (4)$$

$$\mu=6\cdot\pi^{5}+\pi^{-3}+2\cdot\pi^{-6}+2\cdot\pi^{-8}+2\cdot\pi^{-10}+2\cdot\pi^{-13}+\pi^{-15}=1836.15267343... \qquad (5)$$

Also in [8] was presented the exact mathematical expressions that connects the proton to electron mass ratio μ and the fine-structure constant α:

$$9\cdot\mu-119\cdot\alpha^{-1}=5\cdot(\varphi+42) \qquad (6)$$

$$\mu-6\cdot\alpha^{-1}=360\cdot\varphi-165\cdot\pi+345\cdot e+12 \qquad (7)$$

$$\mu-182\cdot\alpha=141\cdot\varphi+495\cdot\pi-66\cdot e+231 \qquad (8)$$

$$\mu-807\cdot\alpha=1205\cdot\pi-518\cdot\varphi-411\cdot e \qquad (9)$$

In [9] was presented the unity formula that connects the fine-structure constant and the proton to electron mass ratio. It was explained that $\mu\cdot\alpha^{-1}$ is one of the roots of the following trigonometric equation:

$$2\cdot10^{2}\cdot\cos(\mu\cdot\alpha^{-1})+13^{2}=0 \qquad (10)$$

The exponential form of this equation is:

$$10^{2}\cdot(e^{i\mu/\alpha}+e^{-i\mu/\alpha})+13^{2}=0 \qquad (11)$$

Also this unity formula can also be written in the form:

$$10\cdot(e^{i\mu/\alpha}+e^{-i\mu/\alpha})^{1/2}=13\cdot i \qquad (12)$$

It was presented in [10] the mathematical formulas that connects the proton to electron mass ratio μ,the fine-structure constant α,the ratio $N_1$ of electric force to gravitational force between electron and proton,the Avogadro's number $N_A$,the gravitational coupling constant $\alpha_G$ of the electron and the gravitational coupling constant of the proton $\alpha_{G(p)}$:

$$4\cdot e^{2}\cdot\alpha^{2}\cdot\alpha_G\cdot N_A^{2}=1 \qquad (13)$$

$$\mu^{2}=4\cdot e^{2}\cdot\alpha^{2}\cdot\alpha_{G(p)}\cdot N_A^{2} \qquad (14)$$

$$\mu \cdot N_1 = 4 \cdot e^2 \cdot \alpha^3 \cdot N_A^2 \quad (15)$$

$$4 \cdot e^2 \cdot \alpha \cdot \mu \cdot \alpha_G^2 \cdot N_A^2 \cdot N_1 = 1 \quad (16)$$

$$\mu^3 = 4 \cdot e^2 \cdot \alpha \cdot \alpha_{G(p)}^2 \cdot N_A^2 \cdot N_1 \quad (17)$$

$$\mu^2 = 4 \cdot e^2 \cdot \alpha_G \cdot \alpha_{G(p)}^2 \cdot N_A^2 \cdot N_1^2 \quad (18)$$

$$\mu = 4 \cdot e^2 \cdot \alpha \cdot \alpha_G \cdot \alpha_{G(p)} \cdot N_A^2 \cdot N_1 \quad (19)$$

In [11] we presented the recommended value for the strong coupling constant:

$$\alpha_s = \frac{Euler' \ number}{Gerford's \ constant} = \frac{e}{e^{\pi}} = e^{1-\pi} = 0,11748.. \quad (20)$$

This value is the current world average value for the coupling evaluated at the Z-boson mass scale.

## 2. Dimensionless unification of the fundamental interactions

In the papers [12] , [13] , [14] and [15] was presented the unification of the fundamental interactions. We found the unity formulas that connect the strong coupling constant $\alpha_s$ and the weak coupling constant $\alpha_w$. We reached the conclusion of the dimensionless unification of the strong nuclear and the weak nuclear interactions:

$$e \cdot \alpha_s = 10^7 \cdot \alpha_w \quad (21)$$

$$\alpha_s^2 = i^{2i} \cdot 10^7 \cdot \alpha_w \quad (22)$$

Resulting the unity formulas that connects the strong coupling constant $\alpha_s$ and the fine-structure constant $\alpha$:

$$\alpha_s \cdot \cos\alpha^{-1} = i^{2i} \quad (23)$$

$$\cos \alpha^{-1} = \frac{\alpha_s^{-1}}{e^{\pi}} \quad (24)$$

The figure 1 below shows the angle in $\alpha^{-1}$ radians. The rotation vector moves in a circle of radius $e^{\pi}$.

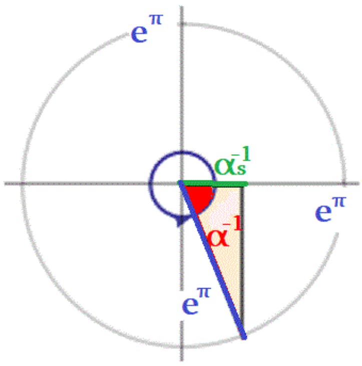


***Figure 1.*** *The angle in $\alpha^{-1}$ radians.The rotation vector moves in a circle of radius $e^{\pi}$.*

We reached the conclusion of the dimensionless unification of the strong nuclear and the electromagnetic interactions:

$$e^{\pi} \cdot \alpha_s \cdot (e^{i/\alpha} + e^{-i/\alpha}) = 2 \quad (25)$$

$$\alpha_s \cdot (e^{i/\alpha} + e^{-i/\alpha}) = 2 \cdot i^{2i} \quad (26)$$

The figure 2 below shows the geometric representation of the dimensionless unification of the strong nuclear and the electromagnetic interactions.

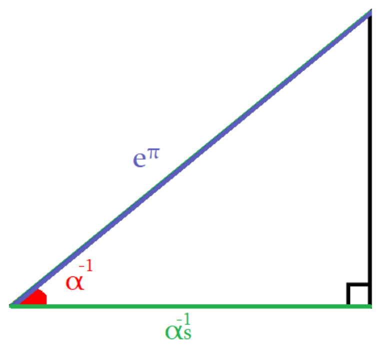


***Figure 2.*** *Geometric representation of the dimensionless unification of the strong nuclear and the electromagnetic interactions.*

The electroweak theory,in physics,is the theory that describes both the electromagnetic force and the weak force. We reached the conclusion of the dimensionless unification of the weak nuclear and the electromagnetic forces:

$$10^7 \cdot \alpha_w \cdot (e^{i/\alpha}+e^{-i/\alpha})=2 \cdot e \cdot i^{2i} \tag{27}$$

The figure 3 below shows the angle in $\alpha^{-1}$ radians. The rotation vector moves in a circle of radius $10^7 \cdot e^{\pi-1}$.

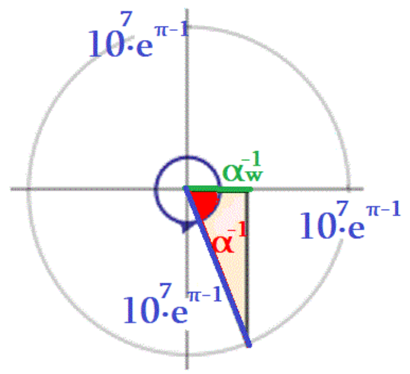


***Figure 3.*** *The angle in $\alpha^{-1}$ radians. The rotation vector moves in a circle of radius* $10^7 \cdot e^{\pi-1}$.

The figure 4 below shows the geometric representation of the dimensionless unification of the weak nuclear and the electromagnetic interactions.

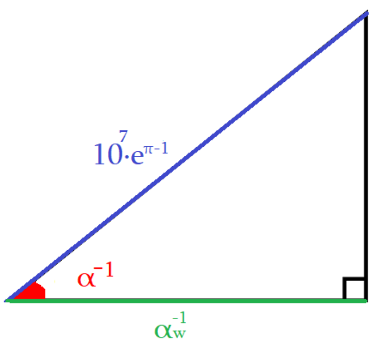


***Figure 4.*** *Geometric representation of the dimensionless unification of the weak nuclear and the electromagnetic interactions*

Resulting the unity formulas that connects the strong coupling constant $\alpha_s$,the weak coupling constant $\alpha_w$ and the fine-structure constant $\alpha$:

$$10^7 \cdot \alpha_w \cdot \cos\alpha^{-1} = \alpha_s \tag{28}$$

$$\cos \alpha^{-1} = \frac{\alpha_s \alpha_w^{-1}}{10^7} \tag{29}$$

The figure 5 below shows the angle in $\alpha^{-1}$ radians. The rotation vector moves in a circle of radius $10^7$.

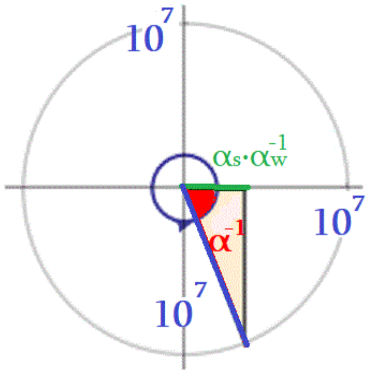


***Figure 5.*** *The angle in $\alpha^{-1}$ radians.The rotation vector moves in a circle of radius $10^7$.*

The figure 6 below shows the dimensionless unification of the strong nuclear,the weak nuclear and the electromagnetic interactions.

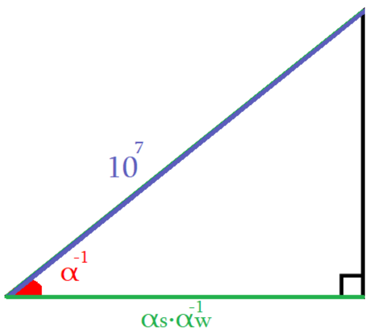


***Figure 6.*** *Geometric representation of the dimensionless unification of the strong nuclear,the weak nuclear and the electromagnetic interactions.*

We reached the conclusion of the dimensionless unification of the strong nuclear,the weak nuclear and the electromagnetic forces:

$$10^7 \cdot \alpha_w \cdot (e^{i/\alpha} + e^{-i/\alpha}) = 2 \cdot \alpha_s \tag{30}$$

Resulting the unity formula that connects the fine-structure constant $\alpha$,the gravitational coupling constant $\alpha_G$ and the Avogadro's number $N_A$:

$$4 \cdot e^2 \cdot \alpha^2 \cdot \alpha_G \cdot N_A^2 = 1 \tag{31}$$

$$\alpha^{-2} \cdot \cos^2\alpha^{-1} = 4 \cdot \alpha_G \cdot N_A^2 \tag{32}$$

The figure 7 below shows the angle in $\alpha^{-1}$ radians. The rotation vector moves in a circle of radius $N_A^{-1}$.

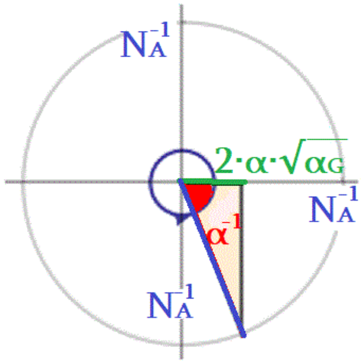


***Figure 7.*** *The angle in $\alpha^{-1}$ radians. The rotation vector moves in a circle of radius $N_A^{-1}$.*

The figures 8 and 9 below show the geometric representation of the dimensionless unification of the gravitational and the electromagnetic interactions.

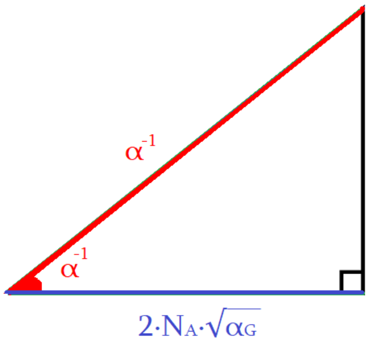


***Figure 8.*** *First geometric representation of the dimensionless unification of the gravitational and the electromagnetic interactions*

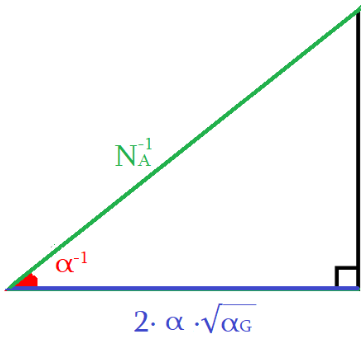


***Figure 9.*** *Second geometric representation of the dimensionless unification of the gravitational and the electromagnetic* interactions

We reached the conclusion of the dimensionless unification of the gravitational and the electromagnetic forces:

$$4\cdot e^2\cdot\alpha^2\cdot\alpha_G\cdot N_A^2=1 \tag{33}$$

$$16\cdot\alpha^2\cdot\alpha_G\cdot N_A^2=(e^{i/\alpha}+e^{-i/\alpha})^2 \tag{34}$$

We reached the conclusion of the dimensionless unification of the strong nuclear,the gravitational and the electromagnetic interactions:

$$4\cdot\alpha_s^2\cdot\alpha^2\cdot\alpha_G\cdot N_A^2=i^{4i} \tag{35}$$

$$\alpha^2\cdot(e^{i/\alpha}+e^{-i/\alpha})\cdot\alpha_s^4\cdot\alpha_G\cdot N_A^2=i^{8i} \tag{36}$$

The figure 10 below shows the geometric representation of the dimensionless unification of the strong nuclear,the gravitational and the electromagnetic interactions.

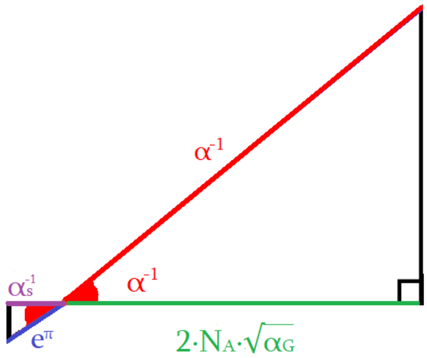


***Figure 10.*** *Geometric representation of the dimensionless unification of the strong nuclear,the gravitational and the electromagnetic interactions*

We reached the conclusion of the dimensionless unification of the weak nuclear,the gravitational and electromagnetic forces:

$$4 \cdot 10^{14} \cdot a_w^2 \cdot a^2 \cdot a_G \cdot N_A^2 = i^{4i} \cdot e^2 \qquad (37)$$

$$10^{14} \cdot a^2 \cdot (e^{i/a} + e^{-i/a})^2 \cdot a_w^2 \cdot a_G \cdot N_A^2 = i^{8i} \qquad (38)$$

The figure 11 below shows the geometric representation of the dimensionless unification of the weak nuclear,the gravitational and the electromagnetic interactions.

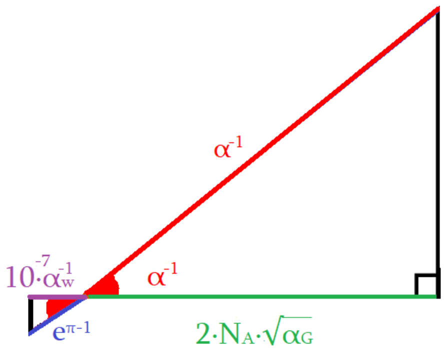


***Figure 11.*** *Geometric representation of the dimensionless unification of the weak nuclear,the gravitational and the electromagnetic interactions*

Resulting the unity formula that connect the strong coupling constant $a_s$,the weak coupling constant $a_w$,the fine-structure constant $a$ and the gravitational coupling constant $a_{G(p)}$ for the proton:

$$4 \cdot 10^{14} \cdot N_A^2 \cdot a_w^2 \cdot a^2 \cdot a_{G(p)} = \mu^2 \cdot a_s^2 \qquad (39)$$

We reached the conclusion of the dimensionless unification of the strong nuclear,the weak nuclear,the gravitational and the electromagnetic interactions:

$$a_s^2 = 4 \cdot 10^{14} \cdot a_w^2 \cdot a^2 \cdot a_G \cdot N_A^2 \qquad (40)$$

$$8 \cdot 10^7 \cdot N_A^2 \cdot a_w \cdot a^2 \cdot a_G = a_s \cdot (e^{i/a} + e^{-i/a}) \qquad (41)$$

The figure 12 below shows the geometric representation of the dimensionless unification of the strong nuclear,the weak nuclear,the gravitational and the electromagnetic interactions.

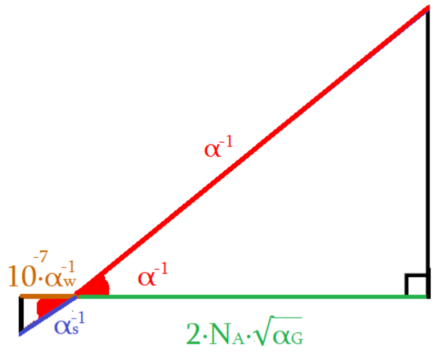


***Figure 12.*** *Geometric representation of the dimensionless unification of the strong nuclear,the weak nuclear,the gravitational and the electromagnetic interactions*

From these expressions resulting the unity formulas that connects the strong coupling constant $\alpha_s$,the weak coupling constant $\alpha_w$,the proton to electron mass ratio $\mu$,the fine-structure constant $\alpha$,the ratio $N_1$ of electric force to gravitational force between electron and proton,the Avogadro's number $N_A$,the gravitational coupling constant $\alpha_G$ of the electron,the gravitational coupling constant of the proton $\alpha_{G(p)}$,the strong coupling constant $\alpha_s$ and the weak coupling constant $\alpha_w$:

$$\alpha_s^2=4\cdot 10^{14}\cdot \alpha_w^2\cdot \alpha^2\cdot \alpha_G\cdot N_A^2 \tag{42}$$

$$\mu^2\cdot \alpha_s^2=4\cdot 10^{14}\cdot \alpha_w^2\cdot \alpha^2\cdot \alpha_{G(p)}\cdot N_A^2 \tag{43}$$

$$\mu\cdot N_1\cdot \alpha_s^2=4\cdot 10^{14}\cdot \alpha_w^2\cdot \alpha^3\cdot N_A^2 \tag{44}$$

$$\alpha_s^2=4\cdot 10^{14}\cdot \alpha_w^2\cdot \alpha\cdot \mu\cdot \alpha_G^2\cdot N_A^2\cdot N_1 \tag{45}$$

$$\mu^3\cdot \alpha_s^2=4\cdot 10^{14}\cdot \alpha_w^2\cdot \alpha\cdot \alpha_{G(p)}^2\cdot N_A^2\cdot N_1 \tag{46}$$

$$\mu\cdot \alpha_s=4\cdot 10^{14}\cdot \alpha_w^2\cdot \alpha_G\cdot G(p)^2\cdot N_A^2\cdot N_1^2 \tag{47}$$

$$\mu\cdot \alpha_s^2=4\cdot 10^{14}\cdot \alpha_w^2\cdot \alpha\cdot \alpha_G\cdot \alpha_{G(p)}\cdot N_A^2\cdot N_1 \tag{48}$$

These equations are applicable for all energy scales. In [16] and [17] we found the expressions for the gravitational constant:

$$G=(2e\alpha N_A)^{-2}\frac{\hbar c}{m_e^2} \tag{49}$$

$$G=i^{4i}(2\alpha_s\alpha N_A)^{-2}\frac{\hbar c}{m_e^2} \tag{50}$$

$$G=i^{4i}e^2\left(2\,10^7\alpha_w\alpha N_A\right)^{-2}\frac{\hbar c}{m_e^2} \tag{51}$$

$$G=\alpha_s^2\left(2\,10^7\alpha_w\alpha N_A\right)^{-2}\frac{\hbar c}{m_e^2} \tag{52}$$

It presented the theoretical value of the Gravitational constant $G=6.67448\times 10^{-11}$ $m^3/kg\cdot s^2$. This value is very close to the 2018 CODATA recommended value of gravitational constant and two experimental measurements from a research group announced new measurements based on torsion balances. They ended up measuring $6.674184\times 10^{-11}$ $m^3/kg\cdot s^2$ and $6.674484\times 10^{-11}$ $m^3/kg\cdot s^2$-of-swinging and angular acceleration methods, respectively.

## 3. Dimensionless unification of atomic physics and cosmology

In [18] and [19] resulting in the dimensionless unification of atomic physics and cosmology. The relevant constant in atomic physics is the fine-structure constant α,which plays a fundamental role in atomic physics and quantum electrodynamics. The analogous constant in cosmology is the gravitational fine-structure constant $\alpha_g$. It plays a fundamental role in cosmology. The mysterious value of the gravitational fine-structure constant $\alpha_g$ is an equivalent way to express the biggest issue in theoretical physics. The mysterious value of the gravitational fine-structure constant $\alpha_g$ is an equivalent way to express the biggest issue in theoretical physics. The gravitational fine structure constant $\alpha_g$ is defined as:

$$\alpha_g = \frac{l_{pl}^3}{r_e^3} = \frac{\sqrt{\alpha_G^3}}{\alpha^3} = \sqrt{\frac{\alpha_G^3}{\alpha^6}} = 1.886837 \times 10^{-61} \quad (53)$$

The expression that connects the gravitational fine-structure constant $\alpha_g$ with the golden ratio φ and the Euler's number e is:

$$\alpha_g = \frac{4e}{3\sqrt{3}\varphi^5} \times 10^{-60} = 1,886837 \times 10^{-61} \quad (54)$$

Resulting the unity formula for the gravitational fine-structure constant $\alpha_g$:

$$\alpha_g=(2\cdot e\cdot \alpha^2\cdot N_A)^{-3} \quad (55)$$

$$\alpha_g=i^{6i}\cdot(2\cdot\alpha_s\cdot\alpha^2\cdot N_A)^{-3} \quad (56)$$

$$\alpha_g=i^{6i}\cdot e^3\cdot(2\cdot 10^7\cdot\alpha_w\cdot\alpha^3\cdot N_A)^{-3} \quad (57)$$

$$\alpha_g=(10^7\cdot\alpha_w\cdot\alpha_G^{1/2}\cdot e^{-1}\cdot\alpha_s^{-1}\cdot\alpha^{-1})^3 \quad (58)$$

$$\alpha_g^2=(10^{14}\cdot\alpha_w^2\cdot\alpha_G\cdot e^{-2}\cdot\alpha_s^{-2}\cdot\alpha^{-2})^3 \quad (59)$$

$$\alpha_g=10^{21}\cdot i^{6i}\cdot\alpha_w^3\cdot\alpha_G^{3/2}\cdot\alpha_s^{-6}\cdot\alpha^{-3} \quad (60)$$

So the unity formulas for the gravitational fine-structure constant $\alpha_g$ are:

$$\alpha_g^2=10^{42}\cdot i^{12i}\cdot\alpha_w^6\cdot\alpha_G^3\cdot\alpha_s^{-12}\cdot\alpha^{-6} \quad (61)$$

The cosmological constant Λ is presumably an enigmatic form of matter or energy that acts in opposition to gravity and is considered by many physicists to be equivalent to dark energy. Nobody really knows what the cosmological constant is exactly,but it is required in cosmological equations in order to reconcile theory with our observations of the universe. Resulting the dimensionless unification of the atomic physics and the cosmology:

$$l_{pl}^2\cdot\Lambda=(2\cdot e\cdot\alpha^2\cdot N_A)^{-6} \quad (62)$$

$$l_{pl}^2\cdot\Lambda=i^{12i}\cdot(2\cdot\alpha_s\cdot\alpha^2\cdot N_A)^{-6} \quad (63)$$

$$l_{pl}^2\cdot\Lambda=i^{12i}\cdot e^6\cdot(2\cdot 10^7\cdot\alpha_w\cdot\alpha^3\cdot N_A)^{-6} \quad (64)$$

$$e^6\cdot\alpha_s^6\cdot\alpha^6\cdot l_{pl}^2\cdot\Lambda=10^{42}\cdot\alpha_G^3\cdot\alpha_w^6 \quad (65)$$

$$\alpha_s^{12}\cdot\alpha^6\cdot l_{pl}^2\cdot\Lambda=10^{42}\cdot i^{12i}\cdot\alpha_G^3\cdot\alpha_w^6 \quad (66)$$

For the cosmological constant Λ equals:

$$\Lambda = \left(2e\alpha^2 N_A\right)^{-6}\frac{c^3}{G\hbar} \quad (67)$$

$$\Lambda = i^{12i}\left(2\alpha_s a^2 N_A\right)^{-6}\frac{c^3}{G\hbar} \tag{68}$$

$$\Lambda = i^{12i}e^6\left(2\,10^7\alpha_w a^3 N_A\right)^{-6}\frac{c^3}{G\hbar} \tag{69}$$

$$\Lambda = 10^{42}\left(\frac{\alpha_G\alpha_w^2}{e^2\alpha_s^2\alpha^2}\right)^3\frac{c^3}{G\hbar} \tag{70}$$

$$\Lambda = 10^{42}i^{12i}\left(\frac{\alpha_G\alpha_w^2}{\alpha^2\alpha_s^4}\right)^3\frac{c^3}{G\hbar} \tag{71}$$

In [20] we found the Equations of the Universe:

$$\frac{\Lambda G\hbar}{c^3} = 10^{42}i^{12i}\left(\frac{\alpha_G\alpha_w^2}{\alpha^2\alpha_s^4}\right)^3 \tag{72}$$

$$e^{6\pi}\frac{\Lambda G\hbar}{c^3} = 10^{42}\left(\frac{\alpha_G\alpha_w^2}{\alpha^2\alpha_s^4}\right)^3 \tag{73}$$

## 4. Poincaré dodecahedral space

In [21] , [22] and [23] we proved that the shape of the Universe is Poincaré dodecahedral space. From the dimensionless unification of the fundamental interactions will propose a possible solution for the density parameter of baryonic matter,dark matter and dark energy. The sum of the contributions to the total density parameter $\Omega_0$ at the current time is $\Omega_0=1.02\pm0.02$. Current observations suggest that we live in a dark energy dominated Universe with $\Omega_\Lambda=0.73$,$\Omega_D=0.23$ and $\Omega_B=0.04$. The figure 21 shows the Geometric representation of the density parameter for the baryonic matter .

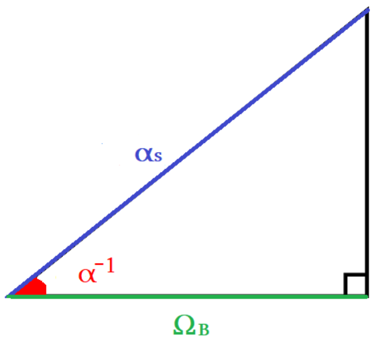


***Figure 21.*** *Geometric representation of the the density parameter for the baryonic matter*

The assessment of baryonic matter at the current time was assessed by WMAP to be $\Omega_B=0.044\pm0.004$. From the dimensionless unification of the fundamental interactions the density parameter for the normal baryonic matter is:

$$\Omega_B=e^{-\pi}=i^{2i}=0.0432=4.32\% \tag{74}$$

From Euler's identity for the density parameter of baryonic matter apply:

$$\Omega_B^{i}+1=0 \tag{75}$$

$$\Omega_B^{i}=i^2 \tag{76}$$

$$\Omega_B^{2i}=1 \tag{77}$$

From the dimensionless unification of the fundamental interactions for the density parameter for normal baryonic matter apply:

$$\Omega_B=e^{-1}\cdot\alpha_s \tag{78}$$

$$\Omega_B=\alpha_w^{-1}\cdot\alpha_s^2\cdot10^{-7} \tag{79}$$

$$\Omega_B=2^{-1}\cdot\alpha_s\cdot(e^{i/\alpha}+e^{-i/\alpha}) \tag{80}$$

$$\Omega_B=2\cdot N_A\cdot\alpha_s\cdot\alpha\cdot\alpha_G^{1/2} \tag{81}$$

$$\Omega_B=2^{-1}\cdot e^{-1}\cdot10^7\cdot\alpha_w\cdot(e^{i/\alpha}+e^{-i/\alpha}) \tag{82}$$

$$\Omega_B=2\cdot10^7\cdot N_A\cdot e^{-1}\cdot\alpha_w\cdot\alpha\cdot\alpha_G^{1/2} \tag{83}$$

$$\Omega_B=10^{-7}\cdot\alpha_g^{1/3}\cdot\alpha_s^2\cdot\alpha\cdot\alpha_w^{-1}\cdot\alpha_G^{-1/2} \tag{84}$$

In [24] we presented the solution for the Density Parameter of Dark Energy. From the dimensionless unification of the fundamental interactions the density parameter for dark energy is:

$$\Omega_\Lambda=2\cdot e^{-1}=0.73576=73.57\% \tag{85}$$

So apply:

$$2\cdot R_d^2=e\cdot L_H^2 \tag{86}$$

Also from the dimensionless unification of the fundamental interactions the density parameter for dark energy is:

$$\Omega_\Lambda=2\cdot\cos\alpha^{-1} \tag{87}$$

So apply the expression:

$$\cos\alpha^{-1}=\frac{\Omega_\Lambda}{2} \tag{88}$$

So the beautiful equation for the density parameter for dark energy is:

$$\Omega_\Lambda=e^{i/\alpha}+e^{-i/\alpha} \tag{89}$$

The figure 22 shows the geometric representation of the density parameter for dark energy.

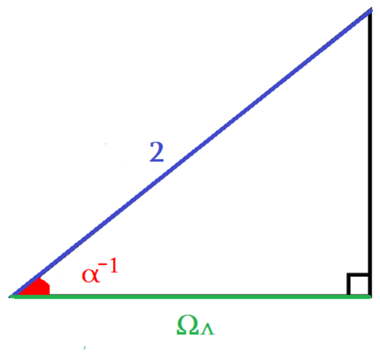


***Figure 22.*** *Geometric representation of the the density parameter for the dark energy*

So apply the expression:

$$\cos \alpha^{-1} = \frac{L_H^2}{2R_d^2} \tag{90}$$

The figure 23 shows the geometric representation of the relationship between the de Sitter radius and the Hubble length.

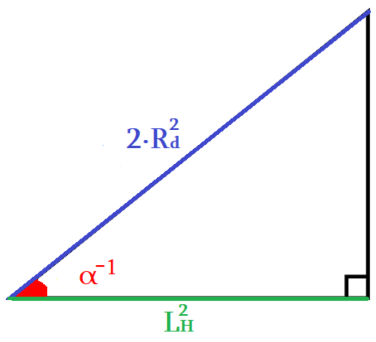


***Figure 23.*** *Geometric representation of the relationship between the de Sitter radius and the Hubble length*

From the dimensionless unification of the fundamental interactions for the density parameter of dark energy apply:

$$\Omega_\Lambda = 2 \cdot 10^{-7} \alpha_s \cdot \alpha_w^{-1} \tag{91}$$

$$\Omega_\Lambda = 2 \cdot i^{2i} \cdot \alpha_s^{-1} \tag{92}$$

$$\Omega_\Lambda = 2 \cdot e \cdot 10^{-7} \cdot i^{2i} \cdot \alpha_w^{-1} \tag{93}$$

$$\Omega_\Lambda = 2 \cdot 10^{-7} \cdot \alpha_s \cdot \alpha_w^{-1} \tag{94}$$

$$\Omega_\Lambda = 4 \cdot \alpha \cdot \alpha_G^{1/2} \cdot N_A \tag{95}$$

$$\Omega_\Lambda = i^{8i} \cdot \alpha^{-2} \cdot \alpha_s^{-4} \cdot \alpha_G^{-1} \cdot N_A^{-2} \tag{96}$$

$$\Omega_\Lambda = 10^{7} \cdot i^{4i} \cdot \alpha^{-1} \cdot \alpha_w^{-1} \cdot \alpha_G^{-1/2} \cdot N_A^{-1} \tag{97}$$

$$\Omega_\Lambda = 8 \cdot 10^{7} \cdot N_A^{2} \cdot \alpha_w \cdot \alpha^{2} \cdot \alpha_G \cdot \alpha_s^{-1} \tag{98}$$

The figure 24 shows the geometric representation of the relationship between the de Sitter radius and the Hubble length.

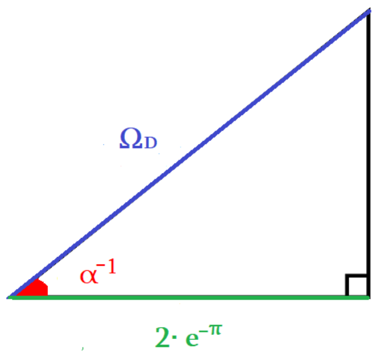


***Figure 24.*** *Geometric representation of the density parameter of dark matter.*

The figure 25 shows the geometric representation of the relationship between the density parameter of dark and baryonic matter.

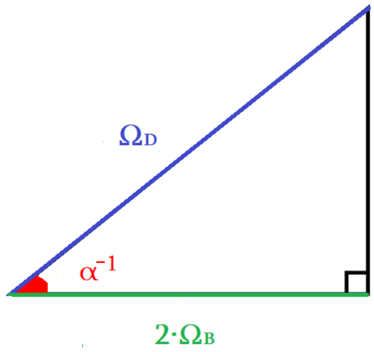


***Figure 25.*** *Geometric representation of the relationship between the density parameter of dark and baryonic matter.*

Current observations suggest that we live in a dark energy dominated Universe with density parameters for dark matter $\Omega_D=0.23$. From the dimensionless unification of the fundamental interactions the density parameter for dark matter is:

$$\Omega_D=2\cdot e^{1-\pi}=2\cdot e\cdot i^{2i}=0.2349=23.49\% \qquad (99)$$

From the dimensionless unification of the fundamental interactions for the density parameter for normal baryonic matter apply:

$$\Omega_D=2\cdot\alpha_s \qquad (100)$$

$$\Omega_D=2\cdot 10^7\cdot e^{-1}\cdot\alpha_w \qquad (101)$$

$$\Omega_D=2\cdot(i^{2i}\cdot 10^7\cdot\alpha_w)^{1/2} \qquad (102)$$

$$\Omega_D=4\cdot i^{2i}\cdot(e^{i/\alpha}+e^{-i/\alpha})^{-1} \qquad (103)$$

$$\Omega_D=10^7\cdot\alpha_w\cdot(e^{i/\alpha}+e^{-i/\alpha}) \qquad (104)$$

$$\Omega_D=4\cdot 10^7\cdot\alpha_w\cdot\alpha\cdot\alpha_G^{1/2}\cdot N_A \qquad (105)$$

$$\Omega_D=16\cdot 10^7\cdot N_A^2\cdot\alpha_w\cdot\alpha^2\cdot\alpha_G\cdot(e^{i/\alpha}+e^{-i/\alpha})^{-1} \qquad (106)$$

The relationship between the density parameter of dark matter and baryonic matter is:

$$\Omega_D=2\cdot e\cdot\Omega_B \qquad (107)$$

The relationship between the density parameter of dark energy,dark matter and baryonic matter is:

$$\Omega_D\cdot\Omega_\Lambda=4\cdot\Omega_B \qquad (108)$$

From the dimensionless unification of the fundamental interactions the sum of the contributions to the total density parameter $\Omega_0$ at the current time is:

$$\Omega_0=\Omega_B+\Omega_D+\Omega_\Lambda=e^{-\pi}+2\cdot e^{1-\pi}+2\cdot e^{-1}=1.0139 \qquad (109)$$

In [25] we proposed a possible solution for the Equation of state in cosmology. From the dimensionless unification of the fundamental interactions the state equation w has value:

$$w=-24\cdot e^{-\pi}=-24\cdot i^{2i}=-1.037134 \qquad (110)$$

## 5. The mass of the observable universe

In [26] , [27] and [28] we presented the law of the gravitational fine-structure constant $α_g$ followed by ratios of maximum and minimum theoretical values for natural quantities.This theory uses quantum mechanics, cosmology, thermodynamics, and special and general relativity. Length $l$,time $t$,speed $υ$ and temperature $T$ have the same min/max ratio which is:

$$α_g = \frac{l_{min}}{l_{\max}} = \frac{t_{min}}{t_{\max}} = \frac{υ_{min}}{υ_{\max}} = \frac{T_{min}}{T_{max}} \tag{111}$$

Energy $E$, mass $M$, action $A$,momentum $P$ and entropy $S$ have another min/max ratio,which is the square of $α_g$:

$$α_g^2 = \frac{E_{min}}{E_{\max}} = \frac{M_{min}}{M_{\max}} = \frac{A_{min}}{A_{\max}} = \frac{P_{min}}{P_{\max}} = \frac{S_{min}}{S_{max}} \tag{112}$$

Force $F$ has min/max ratio which is $α_g^4$:

$$α_g^4 = \frac{F_{min}}{F_{max}} \tag{113}$$

Mass density has min/max ratio which is $α_g^5$:

$$α_g^5 = \frac{ρ_{min}}{ρ_{max}} \tag{114}$$

The Planck mass $m_{pl}$ appears everywhere in astrophysics,cosmology,quantum gravity,string theory,etc. Its mass is enormous compared to any subatomic particle and even the mass of heavier atoms. The mass Planck $m_{pl}$ can be defined by three fundamental natural constants,the speed of light in vacuum $c$,the reduced Planck constant $ħ$ and the gravity constant $G$ as:

$$m_{pl} = \sqrt{\frac{\hbar c}{G}} = \frac{\hbar}{l_{pl}c} = \frac{μ_0 q_{pl}^2}{4\pi l_{pl}}$$

In [29] we presented the Unification of the Microcosm and the Macrocosm. In [30] J.Forsythe and T. Valev found an extended mass relation for seven fundamental masses. Six of these masses are successfully identified as mass of the observable universe, Eddington mass limit of the most massive stars, mass of hypothetical quantum “Gravity Atom” whose gravitational potential is equal to electrostatic potential , Planck mass, Hubble mass and mass dimension constant relating masses of stable particles with coupling constants of fundamental interactions. We found two similar mass relation for seven fundamental masses:

$$M_n = α^{-1} \cdot α_g^{(2-n)/3} \cdot m_e \tag{115}$$

$$M_n = α_g^{-n/3} \cdot M_{min} \tag{116}$$

$$n = 0,1,2,3,4,5,6$$

For $n=0$ $M_0$ is the minimum mass $M_{min}$:

$$M_0 = M_{min} = α^{-1} \cdot α_g^{(2-0)/3} \cdot m_e = α^{-1} \cdot α_g^{2/3} \cdot m_e \tag{117}$$

For $n=1$ $M_1$ is unidentified and could be regarded as a prediction by the suggested mass relation for unknown fundamental mass $M_{Un}$ ,most likely a yet unobserved light particle:

$$M_1 = M_{Un} = α^{-1} \cdot α_g^{(2-1)/3} \cdot m_e = α^{-1} \cdot α_g^{1/3} \cdot m_e \quad M_1 = α_g^{-1/3} \cdot M_{min} \tag{118}$$

For $n=2$ $M_2$ is a mass dimension constant in a basic mass equation relating masses of stable particles and coupling constants of the four interactions approximately a half charged pion mass $M_{pi}$:

$$M_2=M_{pi}=\alpha^{-1}\cdot\alpha_g^{(2-2)/3}\cdot m_e=\alpha^{-1}\cdot m_e=\alpha_g^{-2/3}\cdot M_{min} \quad (119)$$

For n=3 $M_3$ is the Planck mass $m_{pl}$:

$$M_3=m_{pl}=\alpha^{-1}\cdot\alpha_g^{(2-3)/3}\cdot m_e=\alpha^{-1}\cdot\alpha_g^{-1/3}\cdot m_e=\alpha_g^{-1}\cdot M_{min} \quad (120)$$

For n=4 is the central mass of a hypothetical quantum "Gravity Atom" $M_{GA}$:

$$M_4=M_{GA}=\alpha^{-1}\cdot\alpha_g^{(2-4)/3}\cdot m_e=\alpha^{-1}\cdot\alpha_g^{-2/3}\cdot m_e=\alpha_g^{-4/3}\cdot M_{min} \quad (121)$$

For n=5 is of the order of the Eddington mass $M_{Edd}$ limit of the most massive stars:

$$M_5=M_{Edd}=\alpha^{-1}\cdot\alpha_g^{(2-5)/3}\cdot m_e=\alpha^{-1}\cdot\alpha_g^{-1}\cdot m_e=\alpha_g^{-5/3}\cdot M_{min} \quad (122)$$

For n=6 is the mass of the Hubble sphere and the mass of the observable universe $M_U$:

$$M_6=M_U=\alpha^{-1}\cdot\alpha_g^{(2-5)/3}\cdot m_e=\alpha^{-1}\cdot\alpha_g^{-4/3}\cdot m_e=\alpha_g^{-2}\cdot M_{min} \quad (123)$$

The following applies to the minimum mass $M_{min}$:

$$M_{min}c^2=\frac{\hbar}{t_{max}}=\hbar H_0 \quad (124)$$

$$M_{min}=\frac{\hbar}{t_{max}c^2}=\frac{\hbar H_0}{c^2}=\frac{\hbar}{cl_{max}}=\frac{\hbar}{c}\sqrt{\Lambda} \quad (125)$$

Therefore for the minimum mass $M_{min}$ apply:

$$M_{min}=\frac{m_{pl}^2}{M_{max}}=\alpha_g m_{pl}=\frac{\alpha_G}{\alpha^3}m_e=\frac{\sqrt[3]{\alpha_g^2}}{\alpha}m_e \quad (126)$$

$$M_{min}=(2\cdot e\cdot N_A)^{-2}\cdot\alpha^{-1}\cdot m_e=4.06578\times10^{-69}\text{ kg} \quad (127)$$

Three independent calculations calculate the mass of the universe $1.46\times10^{53}$ kg, $1.7\times10^{53}$ kg and $1.20\times10^{53}$ kg. In this context,mass refers to ordinary matter and includes the interstellar medium (ISM) and the intergalactic medium (IGM). However,it excludes dark matter and dark energy. This reported value for the mass of ordinary matter in the universe can be estimated on the basis of critical density infinite. So to estimate the mass value of the universe we will calculate the average of the three independent calculations that produce relatively close results. So the $M_U$ mass of the observable universe is approximately $M_U≈1.45\times10^{53}$ kg. Mass M have max/min ratio,which is the square of $\alpha_g$:

$$\alpha_g^2=\frac{M_{min}}{M_{max}} \quad (128)$$

For the maximum mass $M_{max}$ applies:

$$M_{max}=\frac{F_{max}l_{max}}{c^2} \quad (129)$$

$$M_{max}=\frac{m_{pl}^2}{M_{min}} \quad (130)$$

The expressions for the mass of the observable universe are:

$$M_U=\alpha^{-1}\cdot\alpha_g^{-4/3}\cdot m_e \quad (131)$$

$$M_U=\alpha^3\cdot\alpha_G^{-2}\cdot m_e \quad (132)$$

$$M_U=(2\cdot e\cdot \alpha^2\cdot N_A)^2\cdot N_1\cdot m_p \quad (133)$$

$$M_U=\mu\cdot\alpha\cdot N_1^2\cdot m_p \quad (134)$$

For the value of the mass of the observable universe $M_U$ apply $M_U=1.153482\times10^{53}$ kg. In astrophysics,the Eddington number, $N_{Edd}$, is the number of protons in the observable universe. Eddington originally calculated it as about $1.57\times10^{79}$,current estimates make it approximately $10^{80}$. The term is named for British astrophysicist Arthur Eddington, who in 1940 was the first to propose a value of $N_{Edd}$ and to explain why this number might be important for physical cosmology and the foundations of physics. The expressions who calculate the number of protons in the observable universe are:

$$N_{Edd}=\frac{M_U}{m_p}=\mu\alpha N_1^2=6.9\times10^{79} \quad (135)$$

$$\frac{M_U}{m_p}=\left(2e\alpha^2 N_A\right)^2 N_1 \quad (136)$$

$$\frac{M_U}{m_p}=\left(\frac{r_e}{l_{pl}}\right)^2 N_1 \quad (137)$$

Also apply the expressions:

$$m_{p\ell}\cdot l_{max}=M_U\cdot l_{pl} \quad (138)$$

$$l^2_{max}\cdot M_{min}=l^2_{min}\cdot M_U \quad (139)$$

## 6. The radius of the observable universe

In [31] and [32] we presented the Dimensionless theory of everything. A Planck length $l_{pl}$ is about $10^{-20}$ times the diameter of a proton,meaning it is so small that immediate observation at this scale would be impossible in the near future. The length Planck $l_{pl}$ has dimension [L]. The length Planck $l_{pl}$ can be defined by three fundamental natural constants,the speed of light at vacuum c,the reduced Planck constant and the gravity constant G as:

$$l_{pl}=\sqrt{\frac{\hbar G}{c^3}}=\frac{\hbar}{m_{pl}c}=\frac{h}{2\pi m_{pl}c}=\frac{m_p r_p}{4m_{pl}}$$

The 2018 CODATA recommended value of the Planck length is $l_{pl}=1.616255\times10^{-35}$ m with standard uncertainty $0.000018\times10^{-35}$ m and relative standard uncertainty $1.1\times10^{-5}$. The classical electron radius is a combination of fundamental physical quantities that define a length scale for problems involving an electron interacting with electromagnetic radiation. The classical electron radius is given as:

$$r_e=\alpha^2\alpha_0=\frac{\hbar\alpha}{m_e c}=\frac{\lambda_c\alpha}{m_e c^2}=\frac{\mu_0}{4\pi}\frac{q_e^2}{m_e}=\frac{k_e q_e^2}{m_e c^2}=\frac{\alpha^3}{4\pi R_\infty}$$

The Bohr radius $\alpha_0$ is a physical constant, approximately equal to the most probable distance between the nucleus and the electron in a hydrogen atom in its ground state. The Bohr radius $\alpha_0$ is defined as:

$$\alpha_0=\frac{\hbar}{\alpha m_e c}=\frac{r_e}{\alpha^2}=\frac{\lambda_c}{2\pi\alpha}$$

The 2018 CODATA recommended value of the Bohr radius is $\alpha_0=5.29177210903\times10^{-11}$ m with standard uncertainty $0.00000000080\times10^{-11}$ m and relative standard uncertainty $1.5\times10^{-10}$. The proton radius $r_p$ is the distance from the center of the proton to the tip of the proton. The proton radius $r_p$ is an unanswered physics problem related to the size of the proton. In atomic physics, there are two common and "natural" scales of length. The first scale of length is given by Compton's wavelength of electrons. Using the de Broglie equation, we get that Compton's wavelength is the wavelength of a photon whose energy is the same as the rest mass of the particle,or mathematically speaking: The Compton wavelength of a particle is equal to the wavelength of a photon whose energy is the same as the mass of that particle. It was introduced by Arthur Compton in his explanation of the scattering of photons by electrons. The standard Compton wavelength λ,of a particle is given by $\lambda_c = h/m \cdot c$. Thus respectively the Compton wavelength $\lambda_c$ of the electron with mass $m_e$ is given by the formula:

$$\lambda_c = \frac{2\pi r_e}{\alpha} = \frac{h}{m_e c}$$

Sometimes the Compton wavelength is expressed by the reduced Compton $\bar{\lambda}_c$ wavelength. When the Compton $\lambda_c$ wavelength is divided by $2 \cdot \pi$,we obtain the reduced Compton $\bar{\lambda}_c$ wavelength,ie the Compton wavelength for 1 radius instead of $2 \cdot \pi$ rad $\bar{\lambda}_c = \lambda_c / 2 \cdot \pi$. The Planck constant,or Planck's constant,is a fundamental physical constant of foundational importance in quantum mechanics. The constant gives the relationship between the energy of a photon and its frequency,and by the mass-energy equivalence,the relationship between mass and frequency. Specifically,a photon's energy is equal to its frequency multiplied by the Planck constant. The constant is generally denoted by h. The reduced Planck constant,equal to the constant divided by $2 \cdot \pi$,is denoted by ħ. For the reduced Planck constant ħ apply $\hbar = a \cdot m_e \cdot a_0 \cdot c$. So the new formula for the Planck length $l_{pl}$ is:

$$l_{pl} = a\sqrt{a_G}\alpha_0 \tag{140}$$

The fine-structure constant is universal scaling factor:

$$\alpha = \frac{2\pi r_e}{\lambda_e} = \frac{\lambda_e}{2\pi\alpha_0} = \frac{r_e}{l_{pl}}\frac{m_e}{m_{pl}} = \sqrt{\frac{r_e}{\alpha_0}}$$

Also the gravitational coupling constant is universal scaling factor:

$$\alpha_G = \frac{m_e^2}{m_{pl}^2} = \frac{\alpha_{G(p)}}{\mu^2} = \frac{\alpha}{\mu N_1} = \frac{\alpha^2}{N_1^2\alpha_{G(p)}} = \left(\frac{2\pi l_{pl}}{\lambda_e}\right)^2 = \left(\alpha\frac{l_{pl}}{r_e}\right)^2 = \left(\frac{l_{pl}}{\alpha\alpha_0}\right)^2$$

A smallest length in nature thus implies that there is no way to define exact boundaries of objects or elementary particles. Max Planck proposed natural units that indirectly discovered the lowest-level properties of free space, all born from equations that simplified the mathematics of physics equations. The fundamental unit of length in this unit system is the Planck length $l_{pl}$. The smallest components will never be seen with the human eye as it is orders of magnitudes smaller than an atom. Thus, it will never be directly observed but it can be deduced by mathematics. We proposed to be a lattice structure, in which its unit cells have sides of length $2 \cdot e \cdot l_{pl}$. Perhaps for the minimum distance $l_{min}$ apply:

$$l_{min} = 2 \cdot e \cdot l_{pl} \tag{141}$$

$$l_{min} = 2 \cdot e^{\pi} \cdot a_s \cdot l_{pl} \tag{142}$$

From expressions apply:

$$\cos a^{-1} = e^{-1}$$

$$\cos a^{-1} \cdot l_{min} = 2 \cdot l_{pl}$$

$$\cos\alpha^{-1} = \frac{2l_{pl}}{l_{min}} \tag{143}$$

The figures 16 below show the geometric representation of the fundamental unit of length.

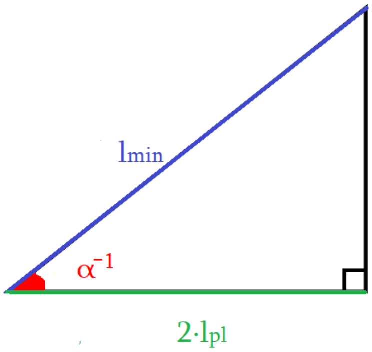


***Figure 16.*** *Geometric representation of the fundamental unit of length.*

For the Bohr radius $a_0$ apply:

$$a_0 = N_A \cdot l_{min}$$

$$a_0 = 2 \cdot e \cdot N_A \cdot l_{pl} \quad (144)$$

The figures 17 below show the geometric representation of the relationship between the Bohr radius and the Planck length.

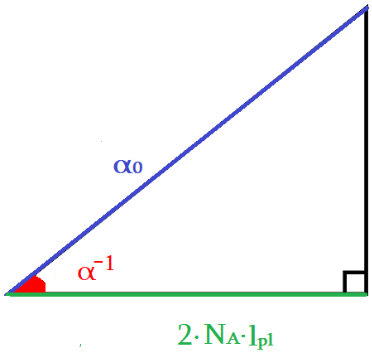


***Figure 17.*** *Geometric representation of the relationship between the Bohr radius and the Planck length.*

We will use this expression and the new formula for the Planck length $l_{pl}$ to resulting the unity formula that connects the fine-structure constant $a$ and the gravitational coupling constant $a_G$:

$$a_0 = 2 \cdot e \cdot N_A \cdot l_{pl}$$

$$\alpha_0 = 2eN_A\alpha\sqrt{\alpha_G}\alpha_0$$

$$2eN_A\alpha\sqrt{\alpha_G} = 1$$

Therefore the unity formula that connect the fine-structure constant $a$,the gravitational coupling constant $a_G$ and the Avogadro's number $N_A$ is:

$$4 \cdot e^2 \cdot a^2 \cdot a_G \cdot N_A^2 = 1 \quad (145)$$

The unity formula is equally valid:

$$a^2 \cdot a_G = (2 \cdot e \cdot N_A)^{-2} \quad (146)$$

Laurent Nottale in [33] which,instead,suggests the identification $m=m_e/a$. He assumed that the cosmological constant $\Lambda$ is the sum of a general-relativistic term and of the quantum,scale-varying,gravitational self-energy of virtual pairs. A renormalization group approach is used to describe its scale-dependence. We argue that the large scale value of $\Lambda$ is reached at the classical electron scale. This reasoning provides with a large-number relation:

$$\alpha\frac{m_{pl}}{m_e}=\left(\frac{L}{l_{pl}}\right)^{\frac{1}{3}}$$

The cosmological constant $\Lambda$ has the dimension of an inverse length squared. The cosmological constant is the inverse of the square of a length L:

$$L=\sqrt{\Lambda^{-1}}$$

For the de Sitter radius equals:

$$R_d=\sqrt{3}L$$

So the de Sitter radius and the cosmological constant are related through a simple equation:

$$R_d=\sqrt{\frac{3}{\Lambda}}$$

The Hubble length or Hubble distance is a unit of distance in cosmology, defined as:

$$L_H=c\cdot H_0^{-1}$$

It is equivalent to 4.420 million parsecs or 14.4 billion light years. (The numerical value of the Hubble length in light years is, by definition, equal to that of the Hubble time in years.) The Hubble distance would be the distance between the Earth and the galaxies which are currently receding from us at the speed of light, as can be seen by substituting $D=c\cdot H_0^{-1}$ into the equation for Hubble's law, $\upsilon=H_0^{-1}\cdot D$. For the density parameter for dark energy apply:

$$\Omega_\Lambda=\left(\frac{L_H}{R_d}\right)^2=\frac{L_H^2}{R_d^2}$$

From the dimensionless unification of the fundamental interactions the density parameter for dark energy is:

$$\Omega_\Lambda=2\cdot e^{-1}=0.73576=73.57\%$$

So from this expression apply:

$$2\cdot R_d^2=e\cdot L_H^2 \tag{147}$$

So apply the expression:

$$\cos\alpha^{-1}=\frac{L_H^2}{2R_d^2} \tag{148}$$

The figure 18 shows the geometric representation of the relationship between the de Sitter radius and the Hubble length.

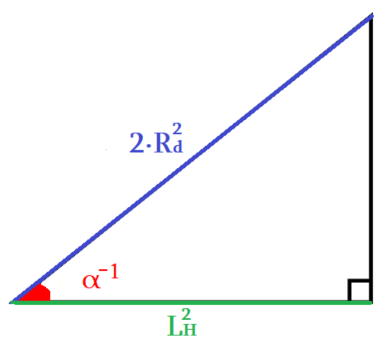


*Figure 18. Geometric representation of the relationship between the de Sitter radius and the Hubble length.*

Length l has the max/min ratio which is:

$$\alpha_g = \frac{l_{min}}{l_{max}} \tag{149}$$

The maximum distance $l_{max}$ corresponds to the distance of the universe:

$$l_{max}=L_H=c\cdot H_0^{-1}=\alpha_g^{-1}\cdot l_{min}=4.656933\times10^{26}\,\mathrm{m} \tag{150}$$

The figure 19 shows the geometric representation of the relationship between the maximum distance and the Planck length.

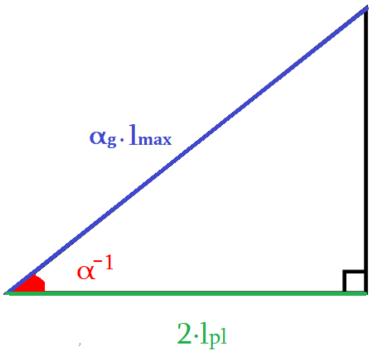


***Figure 19.*** *Geometric representation of the relationship between the maximum distance and the Planck length.*

The enormous value of the ratio of electric force to gravitational force was first pointed out by Bergen Davis in 1904. But Weyl and Eddington suggested that the number was about $10^{40}$ and was related to cosmological quantities. The electric force $F_c$ between electron and proton is defined as:

$$F_c = \frac{q_e^2}{4\pi\varepsilon_0 r^2}$$

The gravitational force $F_g$ between electron and proton is defined as:

$$F_g = \frac{G m_e m_p}{r^2}$$

So from these expressions we have:

$$N_1 = \frac{F_e}{F_g} = \frac{q_e^2}{4\pi\varepsilon_0 G m_e m_p} = \frac{k_e q_e^2}{G m_p m_e} = \frac{\alpha\hbar c}{G m_e m_p}$$

So the ratio $N_1$ of electric force to gravitational force between electron and proton is defined as:

$$N_1 = \frac{\alpha}{\mu\alpha_G} = \frac{\alpha\mu}{\alpha_{G(p)}} = \frac{\alpha}{\sqrt{\alpha_G\alpha_{G(p)}}} = \frac{k_e q_e^2}{G m_e m_p} = \frac{\alpha\hbar c}{G m_e m_p}$$

The approximate value of the ratio of electric force to gravitational force between electron and proton is $N_1=2.26866072\times10^{39}$. The ratio $N_1$ of electric force to gravitational force between electron and proton can also be written in expression:

$$N_1 = \frac{5}{3}2^{130} = 2,26854911 \times 10^{39}$$

According to current theories N1 should be constant. The ratio N2 of electric force to gravitational force between two electrons is defined as:

$$N_2 = \mu N_1 = \frac{\alpha}{\alpha_G} = \frac{N_1^2 \alpha_{G(p)}}{\alpha} = \frac{k_e q_e^2}{G m_e^2} = \frac{\alpha \hbar c}{G m_e^2}$$

The approximate value of N2 is $N_2=4.16560745\times10^{42}$. According to current theories N2 should grow with the expansion of the universe. The observable universe is a ball-shaped region of the universe comprising all matter that can be observed from Earth or its space-based telescopes and exploratory probes at the present time, as the electromagnetic radiation from these objects has had time to reach the Solar System and Earth since the beginning of the cosmological expansion. Initially it was estimated that there may be 2 trillion galaxies in the observable universe,although that number was reduced in 2021 to only several hundred billion based on data from New Horizons. Assuming the universe is isotropic, the distance to the edge of the observable universe is roughly the same in every direction. That is, the observable universe is a spherical region centered on the observer. Every location in the universe has its own observable universe, which may or may not overlap with the one centered on Earth.

According to calculations, the current comoving distance proper distance, which takes into account that the universe has expanded since the light was emitted to particles from which the cosmic microwave background radiation (CMBR) was emitted, which represents the radius of the visible universe, is about 14.0 billion parsecs (about 45.7 billion light-years), while the comoving distance to the edge of the observable universe is about 14.3 billion parsecs (about 46.6 billion light-years),about 2% larger. The radius of the observable universe is therefore estimated to be about 46.5 billion light-years and its diameter about 28.5 gigaparsecs (93 billion light-years, or $8.8\times10^{26}$ meters or $2.89\times10^{27}$ feet), which equals 880 yottameters. The figure 20 shows the geometric representation of the relationship between the radius of the universe with the Planck length.

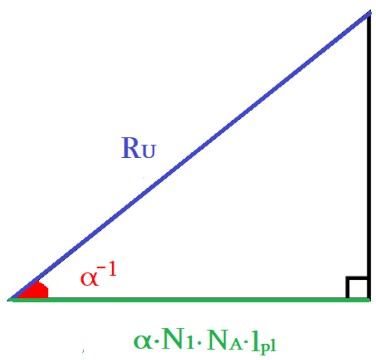


***Figure 20.*** *Geometric representation of the relationship between the radius of the universe with the Planck length*

The diameter of the observable universe will be calculated to be equal to the product of the ratio of electric force to gravitational force between electron and proton on the reduced Compton wavelength of the electron:

Diameter of the universe=ratio of electric force to gravitational force reduced×Compton wavelength of the electron

$$2\cdot R_U = N_1 \cdot \lambda\!\!\!^{-}_c \quad (151)$$

So apply the expressions:

$$R_U = e\cdot\alpha\cdot N_1\cdot N_A\cdot l_{pl} \quad (152)$$

$$2\cdot R_U = \alpha\cdot N_1\cdot N_A\cdot l_{min} \quad (153)$$

$$\frac{2R_U}{l_{min}} = \alpha N_1 N_A \quad (154)$$

$$\frac{2R_U}{r_e} = \frac{N_1}{\alpha} \quad (155)$$

$$\frac{2R_U}{r_e} = \frac{1}{\mu\alpha_G} \tag{156}$$

$$\frac{2R_U}{\alpha_0} = \alpha N_1 \tag{157}$$

So apply the expressions for the radius of the observable universe:

$$R_U = \frac{\alpha N_1}{2}\alpha_0 \tag{158}$$

$$R_U = \frac{N_1}{2\alpha} r_e \tag{159}$$

$$R_U = \frac{1}{2\mu\alpha_G} r_e \tag{160}$$

$$R_U = \frac{m_{pl}^2 r_e}{2m_e m_p} \tag{161}$$

$$R_U = \frac{\hbar c r_e}{2Gm_e m_p} \tag{162}$$

$$R_U = \frac{\alpha\hbar}{2Gm_e^2 m_p} \tag{163}$$

For the value of the radius of the universe apply $R_U = 4.38\times10^{26}$ m. The expressions for the gravitational constant are:

$$G = \frac{\hbar c r_e}{2m_e m_p}\frac{1}{R_U} \tag{164}$$

$$G = \frac{\alpha\hbar}{2m_e^2 m_p}\frac{1}{R_U} \tag{165}$$

The expressions for the relationship between the mass of the observable universe $M_U$ with the radius of the universe $R_U$ are:

$$\frac{M_U}{R_U^2} = 4\mu^2\alpha^3\frac{m_e}{r_e^2} \tag{166}$$

$$\frac{M_U}{R_U^2} = 16\frac{m_p}{r_p r_e} \tag{167}$$

$$\frac{M_U}{R_U^2} = \frac{64}{\alpha}\frac{m_e}{r_p^2} \tag{168}$$

$$\frac{M_U}{m_p} = \alpha\mu\left(\frac{2R_U}{r_e}\right)^2 \tag{169}$$

$$\frac{\frac{M_U}{m_p}}{\left(\frac{2R_U}{r_e}\right)^2} = \alpha\mu \tag{170}$$

## 7. The age of the observable universe

The Planck time $t_{pl}$ is the time required for light to travel a distance of 1 Planck length in vacuum. No current physical theory can describe timescales shorter than the Planck time, such as the earliest events after the Big Bang. Some conjecture that the structure of time need not remain smooth on intervals comparable to the Planck time. Today it plays a tantalizing role in our understanding of the Big Bang and the search for a theory of quantum gravity. All scientific experiments and human experiences occur on time scales that are many orders of magnitude larger than the Planck time $t_{p\ell}$,making events on the Planck time $t_{pl}$ undetectable with current scientific technology. The Planck time $t_{pl}$ is defined as:

$$t_{pl} = \frac{l_{pl}}{c} = \sqrt{\frac{\hbar G}{c^5}} = \frac{\hbar}{m_{pl}c^2}$$

The 2018 CODATA recommended value of the Planck time is $t_{pl}=5.391247\text{x}10^{-44}$ s with standard uncertainty $0.000060\text{x}10^{-44}$ s and relative standard uncertainty $1.1\times10^{-5}$. The gamma rhythm is a pattern of neuronal oscillations whose frequency ranges from 25 Hz to 100 Hz although 40 Hz is typical. Gamma frequency oscillations are present during wakefulness and REM sleep. Changes in electrical membrane potential generate neuronal action potentials. Oscillatory activity of neurons is connected to these spikes. The oscillation of the single neuron can be observed in fluctuations at the threshold of the membrane potential. The time quantum in the brain $t_B$,the smallest unit of time that related to the 40 Hz oscillation of the gamma rate:

$$\frac{t_B}{t_{pl}} = \sqrt[3]{\alpha_g^2} \tag{171}$$

For the minimum distance $l_{min}$ apply:

$$l_{min}=2\cdot e\cdot l_{pl}$$

So for the minimum time $t_{min}$ apply:

$$t_{\text{min}} = \frac{l_{min}}{c}$$

$$t_{\text{min}} = \frac{2el_{pl}}{c}$$

$$t_{min}=2\cdot e\cdot t_{pl}$$

From expressions apply:

$$\cos\alpha^{-1}=e^{-1}$$

$$\cos\alpha^{-1}\cdot t_{min}=2\cdot t_{pl}$$

$$\cos\alpha^{-1} = \frac{2t_{pl}}{t_{min}} \tag{172}$$

The figures 21 below show the geometric representation of the fundamental unit of time.

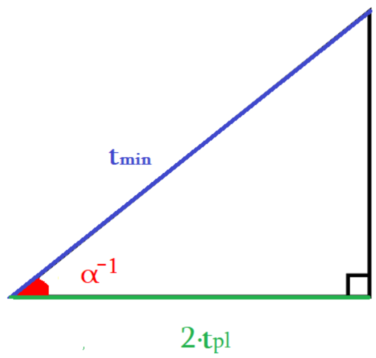


***Figure 21.*** *Geometric representation of the fundamental unit of time.*

The Hubble constant $H_0$ is one of the most important numbers in cosmology because it is required to estimate the size and age of the universe. This number indicates the rate at which the universe is expanding. The Hubble constant can be used to determine the inherent brightness and masses of stars in nearby galaxies,examine the same properties in more distant galaxies and galaxy clusters,infer the amount of dark matter in the universe,and obtain the scale size of distant clusters as far as clusters test for theoretical cosmological models. In 1929,American astronomer Edwin Hubble announced his discovery that galaxies,in all directions,seemed to be moving away from us and have greater displacement for attenuated galaxies. The unit of the Hubble constant is 1 km/s/Mpc. The 2018 CODATA recommended value of the Hubble constant is $H_0=67.66\pm0{,}42$ (km/s)/Mpc=$(2.1927664\pm0.0136)\times10^{-18}$ $s^{-1}$. Hubble length or Hubble distance is a unit of distance in cosmology,defined as the speed of light multiplied by Hubble time $L_H=c\cdot H_0^{-1}$. This distance is equivalent to 4.550 million parsecs,or 14.4 billion light-years,13.8 billion years. Hubble's distance would be the distance between the Earth and the galaxies currently falling away from us at the speed of light,as shown by the substitution $r=c\cdot H_0^{-1}$ in the equation for Hubble's law,$u=H_0\cdot r$. The maximum time period $t_{max}$ is the time from the time of Bing Bang to the present day. This time period corresponds to the time of the universe $t_U=H_0^{-1}$. Therefore:

$$t_{max}=t_U=H_0^{-1}$$

Time t has the min/max ratio which is.

$$\alpha_g=\frac{t_{min}}{t_{max}}$$

$$\alpha_g=t_{min}\cdot H_0=2\cdot e\cdot t_{pl}\cdot H_0 \tag{173}$$

R. Adler in [34] calculated the energy ratio in cosmology,the ratio of the dark energy density to the Planck energy density:

$$\frac{\rho_\Lambda}{\rho_{pl}}=\frac{\alpha_g^2}{8\pi}$$

So for the ratio of the dark energy density to the Planck energy density apply:

$$\frac{\rho_\Lambda}{\rho_{pl}}=\frac{2e^2\varphi^{-5}}{3^3\pi\varphi^5}\times10^{-120} \tag{174}$$

In the 18th century,the concept that the age of Earth was millions, if not billions, of years began to appear. Nonetheless, most scientists throughout the 19th century and into the first decades of the 20th century presumed that the universe itself was Steady State and eternal, possibly with stars coming and going but no changes occurring at the largest scale known at the time. The first scientific theories indicating that the age of the universe might be finite were the studies of thermodynamics, formalized in the mid-19th century. The concept of entropy dictates that if the universe (or any other closed system) were infinitely old, then everything inside would be at the same temperature, and thus there would be no stars and no life. No scientific explanation for this contradiction was put forth at the time.

In 1915 Albert Einstein published the theory of general relativity and in 1917 constructed the first cosmological model based on his theory. In order to remain consistent with a steady-state universe, Einstein added what was later called a cosmological constant to his equations. Einstein's model of a static universe was proved unstable by Arthur Eddington. The first direct observational hint that the universe was not static but expanding came from the observations of 'recession velocities', mostly by Vesto Slipher, combined with distances to the 'nebulae' (galaxies) by Edwin Hubble in a work published in 1929. Earlier in the 20th century, Hubble and others resolve individual stars within certain nebulae, thus determining that they were galaxies, similar to, but external to, our Milky Way Galaxy. In addition, these galaxies were very large and very far away. Spectra taken of these distant galaxies showed a red shift in their spectral lines presumably caused by the Doppler effect, thus indicating that these galaxies were moving away from the Earth. In addition, the farther away these galaxies seemed to be (the dimmer they appeared to us) the greater was their redshift, and thus the faster they seemed to be moving away. This was the first direct evidence that the universe is not static but expanding. The first estimate of the age of the universe came from the calculation of when all of the objects must have started speeding out from the same point. Hubble's initial value for the universe's age was very low, as the galaxies were assumed to be much closer than later observations found them to be.

The first reasonably accurate measurement of the rate of expansion of the universe, a numerical value now known as the Hubble constant, was made in 1958 by astronomer Allan Sandage. His measured value for the Hubble constant came very close to the value range generally accepted today. Sandage, like Einstein, did not believe his own results at the time of discovery. Sandage proposed new theories of cosmogony to explain this discrepancy. This issue was more or less resolved by improvements in the theoretical models used for estimating the ages of stars. As of 2013, using the latest models for stellar evolution, the estimated age of the oldest known star is 14.46±0.8 billion years. The discovery of microwave cosmic background radiation announced in 1965 finally brought an effective end to the remaining scientific uncertainty over the expanding universe. It was a chance result from work by two teams less than 60 miles apart. In 1964, Arno Penzias and Robert Wilson were trying to detect radio wave echoes with a supersensitive antenna. The antenna persistently detected a low, steady, mysterious noise in the microwave region that was evenly spread over the sky, and was present day and night. After testing, they became certain that the signal did not come from the Earth, the Sun, or our galaxy, but from outside our own galaxy, but could not explain it. At the same time another team, Robert H. Dicke, Jim Peebles, and David Wilkinson, were attempting to detect low level noise that might be left over from the Big Bang and could prove whether the Big Bang theory was correct. The two teams realized that the detected noise was in fact radiation left over from the Big Bang, and that this was strong evidence that the theory was correct. Since then, a great deal of other evidence has strengthened and confirmed this conclusion, and refined the estimated age of the universe to its current figure. The space probes WMAP, launched in 2001, and Planck, launched in 2009, produced data that determines the Hubble constant and the age of the universe independent of galaxy distances, removing the largest source of error.

In physical cosmology, the age of the universe is the time elapsed since the Big Bang. Astronomers have derived two different measurements of the age of the universe: a measurement based on direct observations of an early state of the universe, which indicate an age of 13.787±0.020 billion years as interpreted with the Lambda-CDM concordance model as of 2021. This distance is equivalent to 4.550 million parsecs,or 14.4 billion light-years,13.8 billion years. Hubble's distance would be the distance between the Earth and the galaxies currently falling away from us at the speed of light,as shown by the substitution $r=c\cdot H_0^{-1}$ in the equation for Hubble's law,$\upsilon=H_0\cdot r$. The Schwarzschild radius or gravitational radius is a physical parameter that appears in the Schwarzschild solution in Einstein's field equations,which corresponds to the radius defining the event horizon of a Schwarzschild black hole. It is a characteristic radius associated with any quantity. (from its center) which must have a celestial body in order to reach a black hole. That is,if a celestial body has a radius less than its Schwarzschild radius then it is a black hole. The term is used especially in physics and astronomy,with emphasis The Schwarzschild ray was named after the German astronomer Karl Schwarzschild,who calculated this exact solution for the theory of general relativity in 1916. The age of the universe is the time elapsed since the Big Bang. Astronomers have derived two different measurements of the age of the universe: a measurement based on direct observations of an early state of the universe, which indicate an age of 13.787±0.020 billion years as interpreted with the Lambda-CDM concordance model as of 2021 and a measurement based on the observations of the local, modern universe, which suggest a younger age. The uncertainty of the first kind of measurement has been narrowed down to 20 million years, based on a number of studies that all show similar figures for the age and that includes studies of the microwave background radiation by the Planck spacecraft, the Wilkinson Microwave Anisotropy Probe and other space probes. Measurements of the cosmic background radiation give the cooling time of the universe since the Big Bang, and measurements of the expansion rate of the universe can be used to calculate its approximate age by extrapolating backwards in time. The range of the estimate is also within the range of the estimate for the oldest observed star in the universe. For the age of the universe apply:

$$T_U = \frac{R_U}{c} \tag{175}$$

$$T_U = \frac{N_1 r_e}{2ac} \tag{176}$$

$$T_U = \frac{r_e}{2\mu\alpha_G c} \tag{177}$$

$$T_U = \frac{\alpha N_1 \alpha_0}{2c} \tag{178}$$

$$T_U = \frac{\alpha\hbar}{2cGm_e^2 m_p} \tag{179}$$

$$T_U = \frac{\hbar r_e}{2Gm_e m_p} \tag{180}$$

For the value of the age of the universe apply $T_U=1.46\times10^{18}$ s. The expressions for the gravitational constant are:

$$G = \frac{\alpha\hbar}{2cm_e^2 m_p}\frac{1}{T_U} \tag{181}$$

$$G = \frac{\hbar r_e}{2m_e m_p}\frac{1}{T_U} \tag{182}$$

## 8. Conclusions

From the dimensionless unification of the fundamental interactions we discover a new simple Large Number Hypothesis which calculates the Mass,the Age and the Radius of the universe. The expressions for the mass of the observable universe are:

$$M_U=\alpha^{-1}\cdot\alpha_g^{-4/3}\cdot m_e=\alpha^3\cdot\alpha_G^{-2}\cdot m_e=(2\cdot e\cdot\alpha^2\cdot N_A)^2\cdot N_1\cdot m_p=\mu\cdot\alpha\cdot N_1^2\cdot m_p=1.153482\times10^{53}\text{ kg}$$

The diameter of the observable universe will be calculated to be equal to the ratio of electric force to gravitational force between electron and proton on the reduced Compton wavelength of the electron:

$$2\cdot R_U=N_1\cdot\bar{\lambda}_c$$

The expressions for the radius of the observable universe are:

$$R_U = \frac{\alpha N_1}{2}\alpha_0 = \frac{N_1}{2\alpha}r_e = \frac{1}{2\mu\alpha_G}r_e = \frac{m_{pl}^2 r_e}{2m_e m_p} = \frac{\hbar c r_e}{2Gm_e m_p} = \frac{\alpha\hbar}{2Gm_e^2 m_p}$$

We Found the value of the radius of the universe $R_U=4.38\times10^{26}$ m. The expressions for the radius of the observable universe are:

$$T_U = \frac{R_U}{c} = \frac{N_1 r_e}{2\alpha c} = \frac{r_e}{2\mu\alpha_G c} = \frac{\alpha N_1 \alpha_0}{2c} = \frac{\alpha\hbar}{2cGm_e^2 m_p} = \frac{\hbar r_e}{2Gm_e m_p}$$

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