

Time and the rhythm of the nature

(Secret of a fine structure constant)

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All processes in the nature and the Universe occur in the rhythm of the nature. This rhythm synchronizes all processes in the nature with nature time. The nature has an own time unit. The fine structure constant is the coefficient linking the unit of our usual time, our second, with the unit of the nature time. The secret of a fine structure constant is opened. The nature has an own rhythm. In the rhythm of nature all changes in the nature, in the world surrounding us, in the Universe are made. The Universe is the materialistic, dynamic, physics object pulsing in the rhythm of the nature. The Universe restricted object in the space (length, extent), on the mass and on the time of the evolution. The age of the Universe represents a Newtonian absolute time.

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Introduction

In the present paper results of author's research on matter of the time and the rhythm of nature and the Universe are presented. The theme of this research is closely intertwined with two other themes. One of them is a theme of fundamental physical constants and in particular the Planck's quantities, such as the Planck's mass, the Planck's length, the Planck's time. Other theme is a theme of evolutionary development of the Universe. The author adheres to a materialistic view at the nature and the Universe. It means that the basic substances of the nature are the material substances and these are the matter, the space and the time. There is their indestructible tie in the nature on the Planck's gauge. From the point of view of physics these substances manifest itself in the form of mass, of the electrical charge, of the space extension or of the length, of the duration or of the time (frequency) and submit to physics laws. These are independent substances of the nature and these are independent physics quantities. The nature on the Planck's gauge is discrete. It is shown that the nature operates with certain discrete quantities of these physics quantities. We will term as their elementary

physics quantities and we will designate the elementary mass as m_α , the elementary Planck's charge as q_α , the elementary charge as e_α , the elementary length as l_α , the elementary time as t_α , the frequency as f_α . Let us define a system of the units of measurement. The mass, the charge, the length, the time will be the basic, independent quantities of this system. It corresponds to independent substances of the nature. We will view all these physical quantities as system of the basic, independent quantities, and we will term this system as the A-system. The A-system is the system of the physics quantities MCLT (mass, a charge, length, time). Unities of these quantities will be accordingly kilogram, α -Coulomb (it will be defined later), meter and second. Such unit system will be a natural unit system, unlike SI. Derivative physics quantities will be, for example, the Planck's charge q_α ($q_\alpha = \alpha^{-1} \cdot e_\alpha$), the Planck's frequency f_α ($f_\alpha = t_\alpha^{-1}$). The author in the present paper in the form of short theses and the brief explanations telescopes and substantiates a series of propositions, proposals.

1. Real system of the Planck's quantities

As it is known the existing system of the Planck's quantities is presented on site NIST¹. We will term this system as P-system and we will designate it $P\{m_P, e_P, l_P, t_P\}$. Here m_P, l_P, t_P is the Planck's quantities of mass, length, time, $e_P = e = 1.60218 \cdot 10^{-19}$ C – elementary charge. The Planck's charge $q_P = 1.87555 \cdot 10^{-18}$ C is the derivative physics quantity. It is known that the fine structure constant relates two charges (elementary and the Planck's charge) the following formula: $e_P^2/q_P^2 = \alpha$. The fine structure constant has been entered into a system of the physics quantities by A. Sommerfeld almost 100 years ago. It is the dimensionless physics quantity and its value up to the present according to NIST is equal to:

$$\alpha = 7.297\,352\,5698 \cdot 10^{-3}.$$

We will view other system of the Planck's quantities as which we will term as R-system and we will designate it $R\{m_R, e_R, l_R, t_R\}$. Formulas of transition from P-system to R-system are presented by following equalities:

$$m_R = m_P/6.525, l_R = l_P/6.525, t_R = t_P/6.525, t_R = t_P/6.525. \quad (1)$$

The numerical coefficient here is equal to numerical value of the quantity $\{m_P c\} = 6.525$. Here c is speed of the light in vacuum. Last equality is equivalent to the following numerical equality:

$$\{m_P l_P\} = \{6.525 \cdot t_P\}.$$

This is relation between of the Planck's P-system quantities. For the Planck's R-system quantities will take place another equality:

$$\{m_R l_R\} = \{t_R\}.$$

¹ <http://physics.nist.gov/constants>

This is key, important equality. It is the nature law. Neither the speed of light nor the Newtonian constant of the gravitation after the transition from P-system to R-system do not change. So constructed system of the Planck's R-system quantities will be natural real system of the Planck's quantities. The Planck's R-system quantities are the variable quantities. The R-system of the Planck's quantities corresponds to the up-to-date epoch of evolutionary development of the Universe. It is clear that fundamental physics constants should be calculated anew taking into account quantities of R-system. All further reasoning will be grounded on the R-system.

2. Theses and explanations

1. First and basic proposition is the postulate about indissoluble unity of three basic substances of the nature. This unity is reflected as the physical law in the form:

$$\{mr\} = \{t\}.$$

Explanation: It is the basic law of the nature. This statement needs to be accepted as a postulate. It is the law of existence of fundamental particles with mass m and Compton radius r . Here t is the Planck's time, the minimum duration in the nature. Expressions in curly brackets designate numerical values of corresponding physics quantities.

2. In the nature there is a hypothetical fundamental particles, the Planck's particles, with a rest mass equal to the Planck's mass m_R , and the Compton's radius equal to the Planck's length l_R . For the Planck's particles the law of existence of fundamental particles is carried out:

$$\{m_R \cdot l_R\} = \{t_R\}.$$

3. Nature has own natural time and an own rhythm. All processes in the nature occur in the rhythm of the nature. There is the natural time unit, the natural second in the nature and in the Universe. Let us term it α -second. Its value is equal to value of the fine-structure constant $\alpha = 7.2973525698 - 03$:

$$1 (\alpha - \text{second}) = \{\alpha\} s = 7.2973525698 - 03 s.$$

Explanation: This equality opens sense of the fine-structure constant. The secret of a fine structure constant is solved in May 2013!

4. With the nature and the Universe inseparably linked cosmological constant (frequency) dimensionless quantity. The cosmological constant defines a rhythm of the nature, the Universe. In this rhythm all processes of the nature at micro level occur. The cosmological constant define itself by equality:

$$U_\alpha = 1.21034 + 44.$$

Explanation: It is possible to approach to definition of this value, having written out a chain of the equalities defining the Newtonian constant of gravitation on a bottom of the Planck's R-system (without index in formula) quantities:

$$G = l^3 m^{-1} t^{-2} = l^3 t^{-3} \cdot t m^{-1} = c^3 \cdot t c \cdot (1 \cdot \text{kg m s}^{-1})^{-1} = c^4 t \cdot (1 \cdot \text{kg m s}^{-1})^{-1},$$

$$c^4 t = c^4 f^{-1}, \{f\} = \{c^4 G^{-1}\}, f = c^4 G^{-1} \cdot (1 \cdot \text{kg m s}^{-1})^{-1} = 1.21034 + 44 \text{ s}^{-1},$$

here c - light speed in vacuum, G – Newtonian constant of gravitation. It is necessary to mean that in this equality the postulate from the first thesis in shape $\{m\} = \{c^{-1}\}$ is used. The following equalities take place too:

$$\{m_R \cdot l_R\} = \{t_R\}, \{m_R \cdot c_R\} = 1, mc = 1 \cdot \text{kg m s}^{-1}.$$

Here are taken as mass and Compton radius the Planck's mass and the Planck's length accordingly. It is necessary to mean that in this chain of equalities the variables of the Planck's R-systems quantities are used. Numerical value of the Planck's frequency (for R-systems) is equal to cosmological constant:

$$U_\alpha = \{f\} = 1.21034 + 44.$$

5. In the nature and the Universe the minimum duration of the time is equal to t_α second. Its value is defined by equality:

$$t_\alpha = (1 \alpha - \text{second}) / U_\alpha = 6.0291808138 - 47 \text{ s}.$$

Let's term this quantity as the elementary time.

6. The α -second is a criterion of duration of all processes occurring at macro level. Time of evolution of the Universe has a limit. The last age of the Universe A_α is equal to value:

$$A_\alpha = U_\alpha (\alpha - \text{second}) = \alpha \cdot U_\alpha \text{ s} = 8.8322702822 + 41 \text{ s}.$$

7. U_α -th part of the α -second is equal to t_α s. It is a criterion of duration of all processes occurring at micro level.

Explanation: α -second as a matter of fact is boundary, the dividing line between micro and macro processes of the nature and Universe.

8. Laws of a gravitational interaction of Newton and Coulomb for two dot electrical charges are valid for the Planck's gauge.

9. Coulomb's law, the law of interaction between two dot electrical charges q_1 and q_2 being apart by distance r from each other for the Planck's gauge (here is vacuum and consequently take place equality $\varepsilon = 1$) should look like:

$$F_{Co} = c^2 \cdot q_1 q_2 r^{-2}. \quad (2)$$

Explanation: Here c is speed of light in vacuum. The factor equal to 10^{-7} which is present at usual formula of a Coulomb's law here is divided between two charges.

10. Numerical value of the Planck's charge is defined under the formula (2), taking into account equality of the Planck's and Coulomb's elementary forces

$$F_{Co} \equiv F_{Pl}, F_{Co} = c^2 \cdot q_\alpha^2 \cdot l_\alpha^{-2} = F_{Pl} = \{c^4 G^{-1}\} \cdot [F_{Pl}] = U_\alpha \cdot [F_{Pl}] = 1.21034 \cdot 10^{44} \text{ N.}$$

From this equality follows that numerical value of the Planck's charge will be equal to:

$$q_\alpha = U_\alpha^{-0.5} \cdot \text{a-C} = 9.08964 \cdot 10^{-23} \text{ a-C.} \quad (3)$$

Numerical value of the elementary charge will be accordingly equal to:

$$e_\alpha = \alpha^{0.5} \cdot q_\alpha = \alpha^{0.5} \cdot U_\alpha^{-0.5} \cdot \text{a-C} = 7.76478 \cdot 10^{-24} \text{ a-C.} \quad (4)$$

Explanation: Within the limits of this thesis transition to the A-system of physical quantities is carried out. Expression in square brackets designates unity of a corresponding physical quantity. We will note that values of charges in formulas (3) and (4) are given not in coulombs, and in alpha-coulombs (a-C). Equality (3) as a matter of fact is definition of unity of an alpha-coulomb and value of quantity of the Planck's charge in alpha-coulombs through a cosmological constant value. Explanation: The charge is the basic quantity in the author's system of the units of measurement. In the system of the units of measurement where the unit of the time is our usual second, value from the formula (4) will be numerical value of the elementary charge. In the system of the units of measurement where the unit of the time is natural α -second the numerical value of the elementary charge will be the value from the formula (3). It is numerical value of the elementary natural charge (an electron or proton charge on the module) taken in the relation to natural time.

11. The Planck's and the Coulomb's elementary forces are equal among themselves and numerically equal to value of a cosmological constant U_α :

$$F_{Pl} = G_\alpha \cdot m_\alpha^2 l_\alpha^{-2} = m_\alpha l_\alpha t_\alpha^{-2} = m_\alpha l_\alpha U_\alpha^2 \cdot [t_\alpha^{-2}] = U_\alpha \cdot [F_{Pl}],$$

$$F_{Co} = c_\alpha^2 \cdot q_\alpha^2 l_\alpha^{-2} = q_\alpha^2 t_\alpha^{-2} = U_\alpha^{-1} U_\alpha^2 \cdot [F_{Pl}] = U_\alpha \cdot [F_{Pl}].$$

Explanation: The narration in article will be prolonged in labels of A-system of physical quantities which are marked with the inferior coefficient α . Labels in formulas are trivial. It is necessary to pay attention that according to the nature basic law (thesis 1):

$$\{m_\alpha l_\alpha\} = \{t_\alpha\}.$$

Also take place next equalities (theses 4, 10):

$$\{t_\alpha\} = \{f_\alpha^{-1}\} = U_\alpha^{-1},$$

$$\{q_\alpha^2\} = U_\alpha^{-1}.$$

12. There is a simple dependence between age of the Universe A_U calculated in seconds of our usual time and calculated in α -seconds of natural time:

$$\{A_U\} s = \{\alpha^{-1} \cdot A_U\} \alpha\text{-seconds.}$$

13. In the course of evolutionary development of the Universe the elementary quantities of the mass, charge, length and time accept following values depending on age A_U of the Universe in seconds:

$$m_\alpha = (A_U/\alpha)^{0.125} \cdot U_\alpha^{-0.25}, (\text{kg}) \quad (5)$$

$$e_\alpha = \alpha^{0.5} \cdot U_\alpha^{-0.5} (\alpha\text{-C, alpha-coulomb}),$$

where e_α is the elementary charge,

$$q_\alpha = U_\alpha^{-0.5} (\alpha\text{-C, alpha-coulomb}),$$

where q_α is the Planck's charge,

$$l_\alpha = (A_U/\alpha)^{-0.125} \cdot U_\alpha^{-0.75}, (\text{m}) \quad (6)$$

$$t_\alpha = \alpha \cdot U_\alpha^{-1} (\text{s}).$$

Explanation: Values of the elementary physical quantities in the above-stated formulas are given in correlation by our usual time. Values of the elementary time and the elementary charge do not depend on age of the Universe. Value of the elementary charge is defined by values of a cosmological constant (frequency) and fine-structure constant. There is a certain analogy between the elementary physics quantities and the Planck's quantities. Fixed for certain age of the Universe the value of the elementary physical quantities inherently are the Planck's quantities. But it is necessary to remember that their values differ from values of the official Planck's quantities on the site of NIST.

14. Let us define c_α as speed of light in vacuum and G_α as the Newtonian constant of gravitation. Their values are dependent on age of the Universe:

$$c_\alpha = l_\alpha / (\alpha^{-1} \cdot t_\alpha) = (A_U/\alpha)^{-0.125} \cdot U_\alpha^{0.25}, \quad (7)$$

$$G_\alpha = l_\alpha^3 m_\alpha^{-1} (\alpha^{-1} \cdot t_\alpha)^{-2} = (A_U/\alpha)^{-0.5}. \quad (8)$$

Explanation: We will note that take place following numerical equality: $c_\alpha = m_\alpha^{-1}$. This relation was used above at search of value of a cosmological constant. Numerical value of quantity of the speed of light in vacuum and numerical value of quantity of the elementary mass during each moment of evolution of the Universe are the mutual-inverse values.

15. Formulas (5), (6), (7), (8) allow to calculate age of the Universe if values of corresponding quantities are known. Especially simple formula of age of the Universe is following from the last formula (8). Next equality takes place:

$$A_U = \alpha \cdot \{G_\alpha^{-2}\} s.$$

Explanation: For the up-to-date epoch of the Universe we know that numerical value of the Newtonian constant of gravitation is equal to $\{G_\alpha\} = \{G\} = 6.67384 - 11$. From here for the up-to-date age of the Universe it follows:

$$A_U = 1.63838 + 18 \text{ s} = 51.92 \text{ billion years.}$$

For calculation of age of the Universe through the speed of light the formula will be such:

$$A_U = \alpha \cdot U_\alpha^2 \cdot \{c_\alpha^{-8}\} \text{ s.}$$

16. Under formulas (4) and (5) for the up-to-date age of the Universe (51.92 billion years) the up-to-date values of the elementary quantities of the mass and the length easily calculate. They are accordingly equal to:

$$m_\alpha = 3.33564 \cdot 10^{-9} \text{ kg,}$$

$$l_\alpha = 2.476929 \cdot 10^{-36} \text{ m.}$$

Explanation: It is easily checked that numerical equality takes place:

$$\{m_\alpha^{-1}\} = \{c\} = 299792458.$$

17. It is clear that fundamental physical quantities should be calculated afresh in connection with the values of the elementary physical quantities of the mass, charge, length and of the time. We give values of some most important physical quantities:

Planck's energy:

$$E_\alpha = m_\alpha c_\alpha^2 = c_\alpha = c = 299792458 \text{ J,}$$

$$E_\alpha / e_\alpha = 3.86093 \cdot 10^{31} \text{ Ev,}$$

$$E_\alpha / q_\alpha = 3.29818 \cdot 10^{30} \text{ Ev;}$$

Dirac's constant:

$$\hbar_\alpha = E_\alpha / f_\alpha = l_\alpha = 2.47693 \cdot 10^{-36} \text{ J s,}$$

$$\hbar_\alpha / e_\alpha = 3.18995 \cdot 10^{-13} \text{ Ev s,}$$

$$\hbar_\alpha / q_\alpha = 2.27500 \cdot 10^{-14} \text{ Ev s;}$$

Planck's constant:

$$h_\alpha = 2\pi\hbar_\alpha = 1.55630 \cdot 10^{-35} \text{ J s,}$$

$$h_\alpha / e_\alpha = 2.00431 \cdot 10^{-12} \text{ Ev s,}$$

$$h_\alpha / q_\alpha = 1.71217 \cdot 10^{-13} \text{ Ev s.}$$

In these formulae the units of joule and the electron-volt should be corrected in appropriate way. All these physical quantities are the functions of the time depend on the age of the Universe. These calculations are made for the values of the elementary and Planck's charges equal to:

$$e_\alpha = 7.76478 \cdot 10^{-24} \text{ (alpha - coulomb),}$$

$$q_\alpha = 9.08964 \cdot 10^{-23} \text{ (alpha - coulomb).}$$

18. For all fundamental particles of the nature with rest mass m and Compton radius r , validly numerical equality:

$$\{m \cdot r\} = U_{\alpha}^{-1}.$$

Explanation: This improvement of sense of the proposition formulated in the first thesis. This is mathematical expression of the physical law which is reflection of the basic law of the nature about indissoluble communication of the basic substances of the nature such as matter (mass), space (length), time (frequency).

19. For a hypothetical fundamental particle whose rest mass equal to the elementary mass m_{α} and whose Compton radius equal to the elementary length l_{α} numerical equality takes place:

$$\{m_{\alpha} \cdot l_{\alpha}\} = (A_U/\alpha)^{0.125} \cdot U_{\alpha}^{-0.25} \cdot (A_U/\alpha)^{-0.125} \cdot U_{\alpha}^{-0.75} = U_{\alpha}^{-1}.$$

Explanation: It means that hypothetical fundamental particle can exist in a reality. Let's term this particle as U-particle. The maximum mass of the U-particle in the nature is equal to the value of the elementary mass (m_{α}). The minimum length in the nature is equal to the value of the elementary length (l_{α}), that is the Compton radius of U-particle.

20. Fundamental particles which are in higher energy state should have major rest mass and smaller Compton radius, according to the formulae:

$$\{m \cdot r\} = U_{\alpha}^{-1}, \{E_{\alpha}\} = \{m_{\alpha} c_{\alpha}^2\} = \{c_{\alpha}\}.$$

We know that it is A. Einstein's formula:

$$E = mc^2.$$

Explanation: It is clear that with magnification of age of the Universe numerical value of the Planck's energy decreases, as light speed decreases.

21. The Universe is the developing material dynamic object with restricted time of the existence, restricted in space and with restricted mass. During each instant of the existence, according to a nature rhythm, the mass and the linear size of the Universe are incremented accordingly by quantity of the one elementary mass and the one elementary length. This magnification means that at each step of a natural rhythm, the fundamental U-particle is as though thrown in the Universe. As a result of decay of these U-particles all Universe is shaped.

22. Avogadro constant. For the up-to-date epoch of the Universe following equalities for value of the speed of light in vacuum take place:

$$\{c_{\alpha}\} = \{c\} = 299\,792\,458, \{c_{\alpha}^{-1}\} = \{c^{-1}\} = 3.33564 \cdot 10^{-9}.$$

Earlier in present paper numerical equality $\{c_{\alpha}\} = \{m_{\alpha}^{-1}\}$ has been erected. For the molar volume of ideal gas equal to

$$V_m = 22.413968 \cdot 10^{-3} m^3$$

under requirements

$$T = 273.15 \text{ K}, p = 101.325 \text{ kPa},$$

takes place the following numerical equality:

$$\{V_m \cdot (c^{-3})^{-1}\} = \{V_m \cdot c^3\} = V_m \cdot m_\alpha^{-3} = 6.039 220 08 \cdot 10^{23}.$$

Explanation: It also is the formula of calculation of an Avogadro number. This formula shows that one atom of ideal gas contains in the volume numerical equal to $\{c^{-3}\} m^3$. In other words distance between atoms of ideal gas under the normal requirements specified above numerical equal to the inverse value of the speed of light. Value of the Avogadro constant according to site of NIST is equal to:

$$N_A = 6.022 141 29 \cdot 10^{23} \text{ mol}^{-1}.$$

Inference

Cosmological constant is unique constant of our Universe. The cosmological constant defines a rhythm of all processes in the nature. It defines duration of evolution of the Universe in the nature time units. The cosmological constant defines value of the minimum duration of the nature time and value of the elementary charge. The elementary time and the elementary charge are the constant, absolute quantities. The cosmological constant and age of the Universe define the elementary mass and the elementary length. The fine structure constant is the coefficient linking the second, our time unit and the α -second, a nature time unit. The speed of light is a variable quantity. It depends on a cosmological constant and age of the Universe. The Newtonian constant of gravitation is a variable quantity. It depends on age of the Universe. It is the gravitational age of the Universe actually. The Universe once in the past has arisen. Once in the future the Universe evolution will end. The up-to-date age of the Universe in α -seconds is equal to the inverse value of a square of the Newtonian constant of gravitation. The maximum age of the Universe is equal to $U_\alpha = 1.21034 + 44 \alpha$ -seconds. Everything presented in article system of the elementary physics quantities represents the axiomatic system constructed with use of a unique fundamental constant of the nature, a cosmological constant. The author presents the explanation of value of the Avogadro constant. In the present paper the view of the author at the nature, the Universe and the nature of things has been presented. Author expresses gratitude to grandson Maksim for joint walks during which time it was well thought over those questions which have found reflection in this article. Author expresses gratitude to L. Smolin whose book "Troubles with physics ..." became one of incentive stimulus in his researches on the physics and the cosmology.