UNIVERSAL EVOLUTION AND FUNDAMENTAL PHYSICAL CONSTANTS

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One of the major discoveries of the XX century is the discovery of non-stationarity of the Universe – its evolution with time. That gave rise to the great idea of global evolution of conservative and live matter, as the process of matter spontaneous self-organization – Universal Evolutionism (Big History).

"Epithet "Universal" – as described by Panov A.D. – has two meanings: first – evolution is considered as an attribute of the Universe or Universum as a whole, and the second – imply that evolution patterns are universal to some extent for different progress stages <…>. The second meaning specifies the genetic relationship of different evolution stages" [1].

In modern cosmology it is assumed that evolution of the matter included several stages of space-time self-organization, in the course of which Universe had passed through vary rapid stage of exponential expansion (inflation) and at present time is expanding following power function, which is the Friedmann equation solution, which includes density of "dark energy" and "dark mass" in accordance with empirical data.

To every Universe evolution stage (phase, epoch, era) a set of physical interactions with particular intrinsic Fundamental Physical Constants (FPC) could be prescribed. So, for example, it is assumed that all fundamental interactions, that is Strong (inter-quark). Weak, Electromagnetic and Gravitational, were united in one "grand-interaction". After $10^{-44}c$ time since the Universe formation, Gravity separated from the other three and the inflation stage commenced. Friedmann's stage of evolution ($10^{-35}c$) commenced with Strong interaction separation. At last, when the Universe existence reached 1c, Weak and Electromagnetic interactions separated. From that moment the present FPC values are established [2]. But the now-days FPC values are still used when analyzing events of time prior to 1c. For example, the above mentioned time $10^{-44}c$ – is the so-termed "Planck time", calculated using now-days values such FPC like speed of light in vacuum C_0, Planck's constant $\hbar$, and gravitation constant G_N.

…..One of the first, who pointed out the possibility of FPC variation with the Universe evolution, was Dirac P.A.M. In 1937, using CGS dimensions for FPC he demonstrated that continualization of characteristic time, which is equal to the ratio of the electric charge to the product of gravitation constant and proton and electron masses, lead to the conclusion that either the charge varies proportionally to time, or gravitation constant varies inversely proportional to time. Dirac was in favour of the second alternative.

….At first, the Dirac's hypothesis was met by the scientific community quite chary. But as of today, investigation of possibility of gradual FPC values variability in the course of the Universe evolution is a fully legitimate problem.

Also "center of gravity" is shifted from the individual constants to dimensionless complexes of dimensionfull FPC [3].

….A more radical point of view on FPC and Universe co-evolution is that to each evolution stage (phase) corresponds individual set of FPC, different from the FPC of the previous and the next stages, but genetically related to them. Those relationships consist in that the set of FPC for any stage is result certain "disaggregation" of FPC the previous stage and certain "aggregation" of FPC the next stage.

….Thus, if we choose a certain set of FPC, responding to the now-day Universe, then FPC of the preceding stage (phase) could be reconstructed by means of application of respective FPC aggregation rules. Next, in Section I we shall specify a set of FPC for now-day Universe evolution stage and in Section II we shall formulate the rules of FPC aggregation and describe scenario of the Universe evolution according to those rules.

All FPC numerical value herein coincide with respective values in SI, but we shall write them in MKS-PLUS system. In that system electric charge unit has the dimension of length and that of temperature is the dimension of inversed length [4].

I. Fundamental physical constants at the present stage of the Universe evolution.

….There is lots of attempts to give an "exact" definition of a Fundamental Physical Constant (FPC) [3]. We shall follow the definition that a FPC is a designated value of certain physical quantity, such as speed of light in vacuum C_0 and an action $\hbar$. Inverse gravitation constant G_N^{-1}, should be classified as a FPC, as a designated value of physical quantity k_g with dimension

$$[k_g] = MT^2 / L^3 .$$

….In the ternary system of units MKS-PLUS, the proton charge is also a designated value e with dimension

$$[e] = L$$

and numerical value $L_0 = 1{,}602\ m$;

electrical constant k_e, definite as reciprocal value of dielectric permittivity of vacuum $4\pi\varepsilon_0$, with dimension

$$[k_e] = LM / T^2 ;$$

magnetic permittivity of vacuum μ_0 with dimension

$$[\mu_0] = M / L ,$$

and Boltzmann's constant k_B with dimension

$$[k_B] = L^3 M / T^2 .$$

….All above mentioned FPC are used for description in the low-energy approximation of such physical interactions as Quantum, Gravitational,

Electromagnetic and Thermal. Beyond those interactions, which we shall classify as Main, there are Strong and Weak interactions which are of high-energy inter-quark and inter-particle processes at sub-nuclear level with about 30 particular FPC [arxiv:astro-ph/0511774]. But due to the fact, that the low-energy FPC basically could be considered as the result of such high-energy processes, description of the now-day Universe conditions could be limited by low-energy FPC consideration. No doubt, low-energy FPC are only "tip of the iceberg", but if we are interested in "iceberg motion", then the following the coordinates of its tip is suffice.

….To each Main interaction a particular natural system of units could be prescribed of (L_0, C_0, A_i) type, in which A_i - is FPC, including in its dimension the dimension of mass. From such type of units system, characteristic parameter of any *i*-th interaction is easily derived, the most important of which are Mass M_i, Energy $M_i C_0^2$, and Dissipation $M_i C_0^2 L_0$ [4].

…..Choosing one of the interactions as an etalon, all others interactions could be derived via FPC of that interaction and the coupling constant α_i. For example, choosing interaction $(L_0, C_0, \hbar)$ as an etalon, characteristic parameters of Gravitational interaction are derived as the product of characteristic parameters of Quantum interaction and coupling constant α_g:

$$\alpha_g = C_0^3 L_0^2 k_g \Big/ \hbar ,$$

which is the ratio of the Gravitational interaction characteristic mass to the Quantum interaction characteristic mass.

…..In addition to above-mentioned «individual» interactions, at modern Universe evolution stage there are "inter-mixed" or conjoint interactions of relativistic and non-relativistic types [4]. So, when unifying Quantum interaction with any other main interaction, due to the requirement of unified interaction coupling constant equality to one, there are two options;

a) to use effective length l_i instead of L_0;

a) to use effective speed υ_i instead of C_0;

For example, in case of uniting of Quantum and Gravitational interactions we have got the following conditions:

$$C_0^3 L_0^2 k_g = \hbar ,$$

therefore in relativistic option the effective length l_g is presented by the following expression:

$$l_g = \sqrt{\hbar \Big/ C_0^3 k_g}$$

which is definitely the proverbial Planck's length.

Other example – is unifying of $(L_0, C_0, k_e)-$ and $(L_0, C_0, \mu_0)-$ interactions. In that case, inherent coupling constant, when choosing the second of them as a standard is presented as:

$$\alpha_{\mu} = \frac{k_e L_0 / C_0^2}{\mu_0 L_0},$$

and conditions of unification:

$$\frac{\mu_0}{k_e} C_0^2 = 1$$

is nothing more than the well-known Maxwell's relationship:

$$\varepsilon_0 \mu_0 C_0^2 = 1.$$

That is why instead of two interactions any of them could be used taking into account that numerical values ε_0 and μ_0 are not arbitrary, but interconnected by unification conditions. For example, in SI system the value $\mu_0 = 4\pi 10^{-7}\, m \cdot kg \cdot s^{-2} \cdot A^{-2}$ is postulated, so for ε_0 we have got the following:

$$\varepsilon_0 = 8{,}85410^{-12}\, m^{-3} kg^{-1} s^4 A^2.$$

…..But inter-mixed interactions are derivatives of the main interactions. That is why the final list of the low-energy FPC, characterizing the present stage of Universe evolution includes the following seven entities:

$$C_0 \cong 3 \cdot 10^8 \, m/s;$$

$$L_0 \cong 1{,}6 \cdot 10^{-19}\, m;$$

$$\hbar \cong 1{,}1 \cdot 10^{-34}\, Joule \cdot s,$$

$$k_B \cong 1{,}4 \cdot 10^{-23}\, \text{Joule} \cdot m;$$

$$k_e \cong 9{,}0 \cdot 10^9\, \text{Newton},$$

$$\mu_0 = 1 \cdot 10^{-7}\, kg/m,$$

$$k_N \cong 1{,}5 \cdot 10^{10}\, kg \cdot s^2 / m^3.$$

…..Next, in Section II, on the basis of that list we shall try to determine FPC characterizing preceding stage of the Universe evolution. It should be pointed out that in other publications (see, for example, [4]) the author included in the list of the now-day FPC the Weak interaction constant – $G_F \cong 1{,}4 \cdot 10^{-62}\, \text{Joule} \cdot m^3$., but that constant is related to sub-nuclear level and as such it should be excluded from the list of the low-energy FPC.

II. Aggregation of the Fundamental Physical Constants: one more scenario of the Universe evolution.

…..All physical quantities in MKS-PLUS system have the following formula of dimension

$$L^x T^y M,$$

in which exponents *x,y* are integers. So all of them could be presented by dots on $X - Y$ plane. Dimension of any physical quantities, like a point on that plane, could be determined as geometric mean of two other dimensions, belonging to integer

straight lines (*x,y=const*) and (*x=const,y*) passing through that point and spaced by the equal number of points on both sides from that point.

Geometric mean of two dimensions could be considered as aggregated physical quantities, and determining of dimensions of physical quantities from an aggregated value, contrary – could be considered as disaggregation.

…..The main idea of reconstruction of the FPC evolution against the background of the Universe evolution is that the now-day FPC are the result of preceding FPC disaggregation, concept of which, in turn, could be obtained by the way of investigation of the different aggregation options of the now-day FPC.

…...If basing on the list of the now-day FPC, presented in Section I, then there is the aggregation option leading to the only one initial interaction. Such option includes the following stages:

a) Preceding to the present stage – stage at which exist two aggregated interactions with constants

$$E_{ag} = \sqrt{k_{e\cdot} \cdot k_B} \cong 3{,}5 \cdot 10^{-7}\, Joule,$$

$$A_{ag} = \sqrt{\mu_0 \cdot k_g} \cong 39\, кг \cdot s/m^2,$$

and quantum $(L_0, C_0, \hbar)$ - interaction.

b) Stage, preceding to the stage (a), at which there are only two active aggregated interactions with constants E_{ag} and

$$M_{ag} = \sqrt{\hbar \cdot A_{ag}} \cong 4{,}1 \cdot 10^{-18} kg$$

c) Initial, stage at which there is only one active interaction with constant.

$$P_{ag} = \sqrt{E_{ag} \cdot M_{ag}} = 1{,}2 \cdot 10^{-12}\, m \cdot kg/s.$$

If you read *abc*-stages as the FPC evolution scenario in reverse order, then at the beginning we have the following system of units:

$$(L_0, C_0, P_{ag}).$$

Characteristic mass of interaction, corresponding to such system is equal to $P_{ag}/C_0 \cong 4 \cdot 10^{-21} kg$, energy is equal to $P_{ag} C_0 \cong 3{,}6 \cdot 10^{-4}\, Joule$, and dissipation is equal to $P_{ag} C_0 L_0 \cong 5{,}7 \cdot 10^{-23}\, Joule \cdot m$.

…..Disaggregation of the initial interaction constant P_{ag} leads us to the stage (b) at which there are two interactions:

$$(L_0, C_0, E_{ag}),$$

$$(L_0, C_0, M_{ag}).$$

In turn, the constant disaggregation M_{ag} leads us to the stage (a) with three interactions:

$$(L_0, C_0, E_{ag}),$$

$$(L_0, C_0, A_{ag}),$$

$$(L_0, C_0, \hbar).$$

And at last, the present stage of Universe evolution, appears as the resulted of the disaggregation of consants E_{ag}, and A_{ag}, contain five interactions, which we discussed in Section I.

Thus, the Dimensional analyses, with our assumptions of the now-day FPC nominal list allows, establishing the FPC evolution stage sequence, which we denoted above as *abc*-scenario. Unfortunately, that scenario is far from the accepted cosmological model. First of all, the initial stage of *abc*-scenario, which could be identified as the stage of inflation in the accepted model, is lacking the Gravitational interactions.

…..At first glance, there could not be absence of Gravity, because this can never be. Because there is well-known fact that in the course of inflation the space-time is created, characterized by Einstein tensor with dimension L^{-2}, which according to General Relativity is related to energy-momentum tensor of dimension Joule/m^3, by the constant of dimension $Newton^{-1}$. In General Relativity that constant is presented by the gravitational constant and speed of light in vacuum ratio: $8\pi G_N \big/ C^4$ [5].

But in MKS-PLUS system dimension of inverse Newton is present in any interaction of (L_0, C_0, A_i)type, where A_i is a FPC of which dimension includes mass dimension. Thus, for the initial interaction (L_0, C_0, P_{ag}), active according to *abc*-scenario at the stage of inflation, the following complex of FPC has the dimension of the inverse Newton:

$$Newton^{-1} = L_0 \big/ (P_{ag} \cdot C_0)$$

So, usage of that complex as a coefficient in GR equations is a quite permitted operation.

…..Other example of discrepancy *abc*-scenario with accepted cosmological model – is the thermal history of the Universe evolution. It is usually assumed that the Universe arose at enormous temperature of about $10^{32} K$ which in the course of expansion gradually diminished to the now-day level of temperature of the microwave background. But, according to *abc*-scenario, the temperature as a physical quantity, related to Boltzmann's constant, emerged only in modern times of FPC evolution, and all preceding stages were cold and dark.

…..All in all, it must be admitted that *abc*-scenario does not get into any orthodox "theoretical gate". But there are certain positive aspects. For example, energy and mass, quite naturally emerging at the stage "*b*", could be those dark energy and dark mass , existence of which have to be considered by the way of introduction of the cosmological constant when modeling the present stage of the Universe evolution.

…..Besides, our scenario supports the hypothesis of the cyclic nature of the Universe evolution. Really, what preceded the initial stage «c»? If to unify multiplicatively all FPC of that stage in the form of the complex $P_{ag} \cdot C_0 \cdot L_0$, then it is fair to assume that the initial mass-less space had only one FPC with dimension of dissipation the value of which, as we established above, is approximately equals to quadruple Boltzmann's constant. Disintegration of that FPC happened in two

stages: first into C_0 and $P_{ag}L_0$, then into P_{ag} and L_0, resulting in emerging of initial interaction. Now let us ask ourselves – what will follow the modern stage of evolution? Since our stage contains Boltzmann's constant as one of the seven FPC, its disintegration is quite possible following the above described scheme and the new cycle of the Universe evolution will commence but with other FPC numerical values.

In conclusion I am sorry for may bad English (In Russian this draft was published 2014-06-16 on site www.sciteclibrary.ru).

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ABSTRACT

Universal Evolution and Fundamental Physical Constants.
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Fundamental physical constants (FPC) and Universe co-evolution is considered, assuming that the individual set of FPC corresponding to each evolution stage (phase), differs from the FPC of the previous and the next stages, but genetically related to them. That relationship is stipulated as the FPC of the any stage is "disaggregation" of the FPC previous stage. A particular version of such co-evolution stages sequence is proposed.
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