Guessed formulae for the elementary particle masses, interpretation and arguments of them and a new view on quantum gravity

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Abstract. Formulae for the masses of elementary particles obtained with guessing are presented in the article. A derivation, which tries to physically interpret these formulae, was also made afterward. Said simplified, it is obtained that particle masses are varying quickly that they are mainly zero and sometimes roughly equal to Planckian mass, while we, as measurers, measure a particle mass only as a time average. Then the arguments, why it is possible that those formulae are not contradictory with known physical facts, and why it is necessary that something like should exist to describe the masses of elementary particles, are listed. The formulae and models are realistic according to the known physics. It is shown also an example which can be verified with a statistical analysis. Some findings are shown, which can survive although maybe formulae will not survive.

Keywords: Elementary particle masses, Quantum gravity, Phenomenology, Fine structure constant, Gravitational constant measurement, Planckian mass, Quantum harmonic oscillator, Rest matter, Hawking radiation, Unruh radiation, Entropy, Uncertainty principle, Quantum information, Thermical distribution, Dimensionless quantities, Thought experiment, Statistical analysis, Variable elementary constants, Special relativity, Vacuum energy, Age of universe, Cosmological constant, Quarks, Hadrons, Higgs boson, Hypothesis, Wave function, Equivalence principle, Neutrino mass, Background independence, Singularity, Interpretation of quantum mechanics, Quantum randomness

1. Introduction

Some years ago some formulae for the masses of the elementary particles [1, 2] were obtained. They will be presented here again together with possible interpretations, models, arguments and counter-arguments. Of course, models have become more concrete after some years.

Guessworks of formulae for fundamental physical numbers occur often, for instance [3]. The number most often guessed is the fine structure constant α, because it is among the most precisely measured quantities. In spite of that my formulae are composed with the gravitational constant G, which is not very precisely measured. Although the main objection against guessed formulae is that a number of simple and fair formulae, which can describe these numbers, is too large to give any possibility for a physical background of such a formula, at least one such example exists, this is Balmer's series in hydrogen atom.

We should be aware that we do not know enough, what space-time and matter are. A theory of quantum gravity will tell more about this. We should also be aware that the quantum mechanics is not a self-consistent theory, because quantum gravity as its foundation is not known. And finally, we should be aware that it should be very simple - as some say that it can be written on a T-shirt. The interpretation of quantum mechanics, so of quantum gravity, should be more understandable. For instance, the objective randomness should be more understandable,‡ although I do not claim that some Bohm's sub-quantum level exists [6]. It is not needed to have more parameters, but connections among known physical parameters should be clarified. Interpretation for quantum field theory should also be more clear. Although it is said that the base of everything is field, measurements show only particles, not field. At the same time, quantum field theory is also a challenge, because it is a very successful theory and it needs only a few modifications that it will tell much more.

In section 2 a development of guessing of an electron mass formula is shown. In section 3 an interpretation or a partial derivation of the electron formula is shown. In section 4 physical arguments for these formulae are presented, so these are physical suppositions which maybe will derive these formulae. In section 5 models for possible variable gravitational constant are analysed. In section 6 formulae for other particles are presented. Here all the main formulae are collected and they build one system. Some of them are surprising and some are not very surprising. In section 7 the main arguments and counter-arguments are collected.

2. Presentation of guessing of the electron formula

The first formula, obtained after one hour of a guesswork with a calculator, was

$$\ln(\mu_e^2) = \frac{-3}{4\alpha} \times 1.00271154(97)\,. \tag{1}$$

‡ Here are two good examples of explanation of randomness, [4, 5].

The digits in brackets (97) mean uncertainty on the last two digits, therefore the last factor of (1) means $1.00271154 \pm 0.00000097$. μ_e^2 is defined as

$$\mu_e^2 = \frac{m_e^2 G}{\hbar c}\,, \tag{2}$$

where m_e is the electron mass, $\hbar = h/(2\pi)$, h is the Planck constant, c is the speed of light, G is the gravitational constant and α is the fine structure constant:

$$m_e = 0.510998910(13)\mathrm{MeV}/c^2\,, \tag{3}$$

$$\frac{G}{\hbar c} = 6.70881(67) \times 10^{-45}\frac{c^4}{\mathrm{MeV}^2}\,, \tag{4}$$

$$\alpha = 1/137.035999679(94)\,. \tag{5}$$

Values for them can be obtained in [7].§ The last number in formula (1) means deviation from the expected quantity $-3/(4\alpha)$.‖ Of course, here I noticed, that the value of $\ln(\mu_e^2)$ is very similar to value of $-3/(4\alpha)$, therefore a deviation from this value is observed.

Therefore, if the formula is turned around, the next formula is obtained:

$$\mu_e^2 = \exp\left(\frac{-3}{4\alpha}\right) \times (1 - 0.243221(76))\,. \tag{6}$$

I searched for physical arguments for this formula. It turned out that μ^2 (for whichever particle) and α are enough physically similar (a force is inversely proportional with a square of distance). Therefore, if the above formula is a right way, then the factor 4/3 should also stand before μ_e^2. (See the derivation in the next rows.) It turned out, that the deviation for the above formula is significantly reduced. So

$$\frac{4}{3}\mu_e^2 = \exp\left(\frac{-3}{4\alpha}\right) \times 1.00904(10)\,. \tag{7}$$

I developed some models, which will be described in the continuation. According to one of the models, the next correction of the formula follows:

$$\frac{4}{3}\mu_e^2 = \left(1 + \frac{4}{3}\alpha\right)\exp\left(\frac{-3}{4\alpha}\right) \times (1 - 0.00068(10))\,. \tag{8}$$

The next coincidence: Landau developed a similar formula [9, 10], as I am:

$$\sqrt{2}\alpha\mu_e^2 = \exp\left(\frac{-\pi}{4\alpha}\right) \times (1 - 0.00153(10))\,. \tag{9}$$

It is essential that $\pi/(4\alpha)$ is very similar to $3/(4\alpha)$. Thus, a number of simple formulae for μ_e is not very large. Otherwise the two formulae obtained with guesswork cannot be so similar.

§ In truth, this was calculated in 1986 [8], but because of a comparability, the newest values are given.
‖ Errors are calculated on a simple way, where all measurement errors are summed up so, that a maximal value is obtained, for instance, if $c = a/b$, then $\sigma_c = (a + \sigma_a)/(b - \sigma_b) - c$, where σ_a, σ_b and σ_c mean measurement errors of a, b and c.

3. An interpretation of the electron formulae (7) and (8)

Formula (7) is very similar to the formula for the average energy of harmonic oscillator W at temperature T

$$W = \frac{h\nu}{2} + \frac{h\nu}{\exp\left(\frac{h\nu}{kT}\right) - 1}\,, \tag{10}$$

where k is the Boltzmann constant, and ν is frequency of the harmonic oscillator. Let us, for now, ignore part $h\nu/2$. Let us replace kT with the electric energy of the electron W_e, and replace W with gravitational energy of the electron W_g and let us suppose that

$$\frac{4}{3}\alpha = \frac{W_e}{h\nu} \tag{11}$$

and

$$\frac{4}{3}\mu_e^2 = \frac{W_g}{h\nu}\,. \tag{12}$$

In that way, formula (7) follows from formula (10). The subtrahend 1, which is not presented in formula (7), is negligible, thus, can be added to formula (7). Expressions for W_g, W_e and for ν are unknown. Indeed, the nature of the gravitational and the electrical forces is very similar, therefore I supposed that factor 4/3 should also stand before μ_e^2. With respecting of this, an improvement from formula (6) to (7) was significant.

Let us try to derive formula (8) (and after this also to derive formula (7)). Let us assume that the quantity α varies statistically by the Boltzmann distribution:

$$\frac{\mathrm{d}n}{\mathrm{d}x} = \frac{1}{f\alpha}\exp\left(\frac{-x}{f\alpha}\right)\,, \tag{13}$$

where f in our example equals 4/3. However, our intention is to use f to show more clearly that the same value appears also before μ_e^2. If (13) is integrated, the average value is:

$$\langle x\rangle = \int_0^\infty x\frac{\mathrm{d}n}{\mathrm{d}x}\mathrm{d}x = \int_0^\infty \frac{x}{f\alpha}\exp\left(\frac{-x}{f\alpha}\right)\mathrm{d}x\,, \tag{14}$$

$$\langle x\rangle = f\alpha\,. \tag{15}$$

So we obtain the expression, which is also in the denominator of the exponent.

Now, let us calculate an average with the assumption that non-zero values are calculated only at $x \geq 1$, so

$$\frac{\mathrm{d}n}{\mathrm{d}x} = 0\,, \tag{16}$$

if $x < 1$, otherwise $\mathrm{d}n/\mathrm{d}x$ is calculated with (13). So

$$\langle x\rangle = \int_1^\infty x\frac{\mathrm{d}n}{\mathrm{d}x}\mathrm{d}x = \int_1^\infty \frac{x}{f\alpha}\exp\left(\frac{-x}{f\alpha}\right)\mathrm{d}x\,. \tag{17}$$

The result is now

$$\langle x\rangle = (1+f\alpha)\exp\left(\frac{-1}{f\alpha}\right)\,. \tag{18}$$

If $f\alpha_{\rm corr}$ is put in the above left side of equation (18), (instead of $(f\alpha)$ as in (15)), we obtain

$$f\alpha_{\rm corr} = (1 + f\alpha)\exp\left(\frac{-1}{f\alpha}\right) . \tag{19}$$

(Essentially, the lower limit of the integral can also be chosen as some infinitesimal value ϵ instead of 1, therefore this is a new, corrected value.)

Because of similar dependence of gravitational and electrostatic force with distance, we can suppose that $\alpha_{\rm corr}$ equals $\langle\mu_e\rangle^2$.

Let us assume that x really means

$$x = f\frac{\langle m_e\rangle^2 G}{\langle\hbar\rangle\langle c\rangle} , \tag{20}$$

so that only G varies in expression (2). Thus, because of physical similarity of α and μ_e^2, formula (19) can be replaced with the next formula:

$$f\langle\mu_e\rangle^2 = (1 + f\alpha)\exp\left(\frac{-1}{f\alpha}\right) . \tag{21}$$

Thus the formula (8) is obtained, if f is replaced with 4/3.

Let us write formula (20) in a more dimensionless form:

$$x = f\langle\mu_e\rangle^2\frac{G}{\langle G\rangle} , \tag{22}$$

where μ_e plays a role of a dimensionless electron mass (or, respectively, written in more natural units) and it does not vary in this example. It can be seen that G is an additional parameter. This is somewhat in contradiction with Duff's opinion [11, 12] that G does not exist. Otherwise, although Duff's opinion is not a physical law, it is very probable, because so far existing success of physical theories is based on a reduction of parameters, but G is an additional parameter here.¶ Of course, this is not an absolute denial that G is variable. At the same time this is also an example for a non-trivial testing of Duff's suppositions.+ My view is a little bit different as Duff's one. I claim that it can be used for decision between two model. His claim is, probably, that this is not possible.

Let us calculate an average value of μ_e if it is said that G does not exist and that only μ_e varies. With assumption that $x = y^2$, and if $x = f\mu_e^2$, then $y = (1/f)^{1/2}\mu_e$. The average value of y is calculated as follows

$$\frac{{\rm d}n}{{\rm d}y}{\rm d}y = \frac{{\rm d}n}{{\rm d}x}\frac{{\rm d}x}{{\rm d}y}{\rm d}y , \tag{23}$$

which gives

$$\langle y\rangle = 2\int_1^\infty \frac{y^2}{f\alpha}\exp\left(\frac{-y^2}{f\alpha}\right){\rm d}y = \tag{24}$$

¶ Special relativity means reduction of parameters, because a parameter absolute space is redundant, gravitational force is redundant at general relativity, etc.

+ Duff's example also means that the principle of the equivalence is strictly respected. But this principle at formula (22) is still valid macroscopically although not microscopically.

$$= \exp\left(\frac{-1}{f\alpha}\right) - \frac{1}{2}\sqrt{f\pi\alpha}\left(\operatorname{erf}\left(\frac{1}{\sqrt{f\alpha}}\right) - 1\right). \tag{25}$$

We can find that $\langle y\rangle^2$ differs from $\langle x\rangle$ for a non-trivial factor, therefore such a variation of y (and thus proportionally to $\sqrt{x}$) is not a simple and a reasonable model for explanation of formula (8). This is because thus formula (8) losses the simplicity of its model and this is its sense. In the continuation a model, where G does not exist will be shown, in spite of this, the model for formula (8) will be simple. But, let us look at derivation of formula (7) before.

Another problem is that at integral (17) quantization exists only below 1, but a different quantization is typical for (10). Below it will be shown, how to solve this problem. Namely, (17) respectively (18), means that value zero is attributed to values $x < 1$, but values $x \geq 1$ have attributed unchanged values. To obtain a complete quantization, value 1 is attributed to values $1 \leq x < 2$, value 2 is attributed to values $2 \leq x < 3$, etc. To obtain the complete quantization, let us properly replace the left side of equation (17), thus the equation is:

$$\langle x\rangle = \int_1^2 \frac{\mathrm{d}n}{\mathrm{d}x}\mathrm{d}x + 2\int_2^3 \frac{\mathrm{d}n}{\mathrm{d}x}\mathrm{d}x + 3\int_3^4 \frac{\mathrm{d}n}{\mathrm{d}x}\mathrm{d}x + ..\,, \tag{26}$$

what gives the result

$$\langle x\rangle = \frac{1}{\exp\left(\frac{1}{f\alpha}\right) - 1}. \tag{27}$$

The obtained result is very similar to equation for harmonic oscillator (10), where such quantization also exists.

Although the deviation of formula (8) is much smaller than the deviation of formula (7), I trust more to formula (7), because it operates only with integer values, which are, the most probably, the only correct ones in quantum mechanics.*

Here it can be continued with erection of the model, where additional parameter G is not necessary. Such a function of μ_e should be found that it will be proportional with x, respectively with gravitational energy. At equation (20), respectively at (22), this energy is varying when G is varying. One unsuccessful model without G is described above. However, let us assume that the particle mass is varying, in spite of this self-gravitational force acts only between this variable mass and a longer time average of this mass. We will see that this μ_e is varying on the same way as G in equation (20).

So we obtain the next equation instead of equation (13):

$$\langle x\rangle \frac{\mathrm{d}n}{\mathrm{d}x} = \frac{1}{f\alpha}\exp\left(\frac{-x}{f\alpha}\right), \tag{28}$$

which replaces equation (15) with

$$\langle x\rangle\langle x\rangle = f\alpha\,, \tag{29}$$

* Indeed, what really happens in quantum gravity theory is not completely clear, so that possibility (8) is not completely proven to the contrary and it is still important a little, because it means an improvement of accuracy.

which is, in essence, the same result, only transformation from $\langle x\rangle$ to $\langle x\rangle\langle x\rangle$ is made.

The left sides of equations (16), (17), (18), (26) and (27) can also be corrected on the same way. The result is the same as the equation (22) would be used. Equation (26) can be so changed to

$$f\langle\mu_e\rangle^2 = \langle x\rangle^2 = \int_1^2 \frac{\mathrm{d}n}{\mathrm{d}x}\mathrm{d}x + 2\int_2^3 \frac{\mathrm{d}n}{\mathrm{d}x}\mathrm{d}x + .. = \frac{1}{\exp\left(\frac{1}{f\alpha}\right) - 1}\,. \tag{30}$$

Therefore, this formula is obtained at the assumption that the products $f\mu_e\langle\mu_e\rangle$ are only integers.

Suppositions and conclusions used in this derivation are as follows:

(i) α, in truth, is varying quickly thermically.

(ii) μ_e is also varying quickly thermically, but by quantum rule, therefore that $f\mu_e\langle\mu_e\rangle$ can be only integers.

(iii) The value of α at momentum zero is more fundamental than at non-zero momentums.

(iv) A part analogous to $h\nu/2$ for harmonic oscillator (or to zero energy) does not exist here.

(v) A frequency is not important at formula (30), although it is analogous to the formula for harmonic oscillator.

(vi) At the same time, this is also a formula for a black hole, but the radius of a black hole is maybe presented only implicitly, therefore it is not important.

(vii) Perhaps, these principles hold also for other elementary particles.

(viii) Formulae (8), (20) and (22) are superfluous. They are here only because of clearer derivation, because (8) shows a lesser deviation, and because (22) presents a simpler model.

4. A more physical interpretation of the formulae

The interpretation in the previous section is more mathematically physical, whereas this will be more physical, because suppositions will be much more analyzed than derivations.

According to the common interpretation of special relativity [13] and also according to General Covariance [14], time runs only if a rest mass exists. Besides, according to my article on an alternative interpretation of special relativity [13], speed of time is dependent from the masses of elementary particles and from masses of macroscopic bodies. Values for mass and time are relative according to the special relativity interpretation. Time is not an independent stuff, which could exist without rest masses. The space is not an independent stuff too, which could exist without time.♯ This can also

♯ This is visible from the special relativity, but maybe it can be concluded also from the quantum mechanics. For instance, Brukner [4] did not enough derive jumps from space circulation of wave function to time-circulation of wave function. However, maybe this can be justified with a connection of space and time.

be concluded from importance of dimensionless constants μs, (which will be analyzed later). These quantities connect space, time and mass. So we can conclude: Particles are a thing of space-time (according to the above thinking) and gravity is also a thing of space-time, therefore the elementary particles create space-time and oppositely. Thus, it is naturally that the elementary particles are built up with the help of gravity, thus they are a type of black holes. Otherwise, if we accept Duff's suppositions [11, 12] where gravity is already implicitly included, it cannot be differently.

This rest mass is built up from the elementary particles and (it is not forbidden) from black holes. Thus, if the masses of elementary particles and black holes†† can be explained, quantum gravity will be explained. Thus, by this logic, elementary particles are also black holes, because μs implicitly contain G.†

One of the main remarks against particles as black holes is that a black hole with a mass smaller than $m_{\rm pl}$ is impossible. Indeed, the above formulae have already given an idea, how this is possible - although a mass of an elementary particle, as we measured it, is only a longer time average, truly this mass is mainly equal to 0, and at some moments it equals $(3/4)m_{\rm pl}^2/\langle m_e\rangle$, (if we have in mind the electrons.‡). Therefore the article proposes an alternative. Thus formulae give the idea, which can also survive without these formulae.

The above inference can also be used for an excuse, why my formula (7) has no part analogous to the part $h\nu/2$, which exists in formula (10). It is known, that this part has a duty to maintain the principle of uncertainty at a zero level. This analogous part is also in vacuum energy. Nonetheless, if the elementary particles do not exist, space-time does not exist, thus nothing can violate the principle of uncertainty: a zero-space is not an empty space or a rest harmonic oscillator.

The ideas from Brukner-Zeilinger interpretation of the quantum mechanics [4] can also be included here. They say that the essence of quantum mechanics is in information and that quantity of information in a small building block is finite and not very large. This is also a claim of Feynman. This inference also helps in the above paragraph. In the masses of elementary particles, (which are the essential information of particles) it should be a finite quantity of information.§ Because elementary particles are these fundamental blocks and in them (and in their masses) should be this minimum of information. (The maximal entropy that describes electron formula (7), also give a hint that my formulae

††Let us define the name "black hole" more generally, because quantum and classical black holes are not the same. Hadley, for instance propose four-dimensional geons [15], what is also one quantum upgrade of black holes.

† A generally accepted visualization is that we live in a space with a net, where the smallest hyper-cube has a side with the Planckian length $l_{\rm pl}$. However, this is not true, corners (or stretching points) of this space-time are elementary particles and distances are only defined with elementary particles.

‡ If we simplify for a moment with a model which is otherwise wrong, but that the idea is evident, it means that it is similarly as, that the mass sometimes jumps to $m_{\rm pl}$, whereas at other times equals to zero.

§ Due to space is finitely small, it is the most probably that the singularities ob black holes also do not exist. This is not enough times mentioned.

are a thing of information.)

Or otherwise, quantum gravity is a cause and not a consequence of the quantum mechanics. The quantum mechanics has space-time as an outer parameter, whereas quantum gravity should not have it as an outer parameter. Quantum gravity should have still less outer parameters. An advantage of the Zeilinger-Brukner interpretation [4] is also that it is less occupied with space-time than the Copenhagen interpretation, and thus it is more occupied with information. Hence, it is a little bit closer to quantum gravity. An advantage of quantum gravity according to quantum mechanics is also that it is also more connected with dimensionless quantities, such as μs of elementary particles. The existence of these dimensionless quantities also means that we are closer to fundamental physics.‖ For arguments for importance of μs we can also borrow finiteness of information, which can be theoretically measured from any physical quantity. In arbitrary units this means that this quantity can be measured on, let us say, six decimal places. But with μ_e^2s (and its interpretation) we achieved a wished effect that a theoretical limit is zero decimal places. Because, in the first approximation, μ_e^2 is a statistical combination of values 0 and 1. In the common quantum mechanics, for instance, this is true for angular momentum.

We can suspect that here in the formulae is not a place for a wave function. However, the wave function is a consequence of principle of uncertainty, therefore a consequence of information. This is, because the principle of uncertainty is more fundamental than wave functions. From the Zeilinger-Brukner interpretation of quantum mechanics [4] it is also evident that wave functions are consequence of continuous space, whereas formulae for the elementary particles (my or any other formulae) space has not yet originated.

We can also ask ourselves, where in the formulae a frequency is hidden, because it is the formula for harmonic oscillator and where is it a radius because we operate with modifications of black holes. If there is a radius, there is also a problem with singularity. However, a foundations of everything are just μs of elementary particles, space-time is only a consequence of them. (Quantum gravity is background independent.) With dimensionless μs we do not need a radius. The double slit experiment (for instance, with electrons) seemingly shows on importance of field in three-dimensional space. However, truly it shows also on a problem of the existence of space, because the existence of an electron path is unknown precisely. Gravitational radius of an electron (as radius of a black hole) is thus also less physically important. (Here I do not think on zero electron radius in quantum electrodynamics.) The double slit experiment is one of the first signs that space, as we imagine it in classical physics, does not exists.¶ The most probably, space alone does not exist, thus quantum field in it does also not exist, but things which exist are measurements or information. Dimensionless μ_e^2 is this essential information, but dimensionful frequency or electron radius are not this essential information [11, 12].

‖ For instance, progressive discoveries of k, c, and $\hbar$ created new and new dimensionless quantities and so approached closer to fundamental causes of physics. The next step will be quantum gravity, but it will need to explain μs of the particles.

¶ Special relativity also gives this hint.

Similarly can be concluded from Markopoulou [16]. Thus, μs are not put in one space, but space is put around them. Therefore absence of frequency and radius is understandable, although not explained.

5. Possible models for variation of the gravitational constant

Although variable gravitational constant G is used, it is not in contradiction with Duff, who says that G does not exist. It is only easier to present a derivation with the variable G than with the variable mass. Othewise, here is mentioned variation of self-gravitational energy is more mentioned here.

For further derivation of quantum gravity (or interpretation of the formulae) it is necessary to go to study the principle of equivalence, which is the base of the classical theory of gravity (it is not precisely so) and of quantum gravity (it will be shown that this principle is here still ever important [17]). I will a little arrange this principle. Namely, if we can achieve a time constant gravitational field, we can also achieve the uniform acceleration. And oppositely, if one object can be uniformly accelerated, then time-constant gravitational field can also exist. Let us transmit this arranged principle to the quantum world. Let us try to find if an uniform acceleration is possible in quantum world. If it is not possible, we can legitimately speculate, that a time-constant gravitational field is also not possible. Besides, this gives conclusions in accordance with the above formulae.

This can be imagined with a thought experiment, where we have a rocket on a quantum propulsion. The simplest version of it is a rocket, accelerated with photons. However, a property of photons is that they can give acceleration only in infinitesimally short pulses, not continuously. This is a quantum rule. Owing to this, if we wish as much as possible a continuous acceleration, we use a lot of photons with small energies. Whereas now, the problem appears elsewhere; a supply of such photon demands to have information about photons. Let us try with as little information as possible, therefore with a maximal possible entropy. This now means supply of thermical photons. Such an inference gives pass over to a formula similar to (30). (This is a version of Unruh radiation, where the cause for acceleration is studied, not its consequences.)

A possible approach to formula (7) can also be made with a thought experiment with a precise measurement of the gravitational constant. The most precise measurement of the gravitational constant is possible with a very small black hole [17], because thus we can achieve the largest gravitational field. (According to formulae above it can be even lighter than m_{pl}.) The radiation of a black hole is also increased if the black hole radius is decreased. In this case its gravity is also weaker (except on the horizon). Thus the most precise measurer of its G is its Hawking radiation. The formula for temperature of Hawking radiation (more dimensionlessly written) is

$$\frac{kT}{m_{\mathrm{pl}}c^2} = \frac{1}{8\pi\mu_{\mathrm{BH}}}\,, \tag{31}$$

where $\mu_{\rm BH}$ is a dimensionless mass of this black hole and $m_{\rm pl}$ is the Planck mass, $m_{\rm pl} = (\hbar c/G)^{1/2}$. (If we write (31) in dimensionful units, we can see that G is hidden in this formula.) Power of radiation P is described with the formula for the black body radiation

$$\frac{{\rm d}P}{{\rm d}\nu} = \frac{2h\nu^3}{c^2}\frac{1}{\exp\left(\frac{h\nu}{kT}\right)-1}\,, \tag{32}$$

thus, radiation is distributed thermically by the formula. (We suppose that Hawking radiation exists. Of course, it is known that it is not proven.) If only one photon is used for the measurement of G, it cannot be said, that G is constant with time, because, of course, energies of thermal photons are not constant. And because photons energies vary thermically, G should also vary thermically, because it is expected a validity of a quantum rule "that only such things exist whose can be measured". The most precise G is measured only by small black holes and it seems that their photons are the only indicators of G. Existence of some physical quantity is conditioned with tools, which are used for a measurement of this quantity.

Thus, in essence, formula (7) is only a fully quantized form of formulae (31) and (32). Both Hawking's and my example show thermical distribution.[+] Thus, a bridge between semi-classical black hole and my formulae is made. The bridge is the variable G.[*] Similarity of formula (7) with Hawking radiation was uncovered after formulae were found, therefore guessing of my formulae was not motivated with this purpose. Anyhow, if we measured G more and more precise, we would found that it varies with time.

Variation of "G" was also found by Hadley's [20] formula

$$\langle G_{\mu\nu}\rangle = \frac{8\pi G}{c^4}\langle T_{\mu\nu}\rangle\,, \tag{33}$$

where this is only a modification of the Einstein equation with the use of averages. Therefore, part $G_{\mu\nu}$ describes curvature of space and part $T_{\mu\nu}$ describes mass-energy part, which causes curvature. In any case, the right part cannot be constant.

In truth, the common quantum mechanics already gives clues that self-gravitational energy is varying. Thus, naively understood quantum mechanics gives that it varies by a modified principle of uncertainty:

$$\sigma_W\sigma_t \geq \hbar/2\,. \tag{34}$$

W in our case means a rest energy (mass) of a particle. However, uncertainty in (34) is not primeval. Namely, the principle of uncertainty is primeval for momentum p and for location x. However, equation (34) is only a derivative from this equation and at all,

[+] I will not be satisfied with the derivation of Hawking radiation, until I know, why it gives precisely thermical distribution. Thus, by all means, until now the most simple derivation [18] is not yet the most simple derivation. Something still more direct should exist.

[*] Some interesting properties of the Hawking radiation can be found in [19]. Otherwise, the problem of this speculation is an infinite gravitational force of photons on a black hole, as it is described. In spite of this, maybe more inclusion of quantum physics would solve this imperfection.

it is not a legitimate one for explanation of the rest energy, so for mass [6]. It can be added to [6] that it is characteristically for momentum and location that they always have their zero location. When the uncertainty is the smallest, those two quantities have distributions in form of the Gauss curves. The most simple description for them is that they have center at zero. However, an average rest energy cannot be equated to zero, therefore the Gauss curve would be always displaced. My formula gives that mass can never be smaller than zero, thus it clarifies this paradox a little. At the same time the entropy is maximally possible what is already present at principle of uncertainty $\sigma_p \sigma_x \leq \hbar/2$.

In some way it seems genuine that mass can be only positive. Gravitational force in the classical physics is only attractive. It is naturally to expect that these properties remain also at quantization of gravity. And this is shown by my formula.♯

6. Formulae for the other particles

On the same principle as for the electron, it was tried also for the other particles. The signs for particles mean masses of the particles.

$$\pi^{\pm} = 139.57018(35)\mathrm{MeV}/c^2\,, \tag{35}$$

$$\ln(\mu^2_{(\pi^{\pm})}) = \frac{-2}{3\alpha} \times 1.0052370(11)\,, \tag{36}$$

$$\frac{3}{2}\mu^2_{(\pi^{\pm})} = \exp\left(\frac{-2}{3\alpha}\right) \times (1 - 0.070375(98))\,, \tag{37}$$

$$\pi^0 = 134.9766(6)\mathrm{MeV}/c^2\,, \tag{38}$$

$$\frac{3}{2}\mu^2_{(\pi^0)} = \exp\left(\frac{-2}{3\alpha}\right) \times (1 - 0.130560(95))\,, \tag{39}$$

$$\frac{0.130560(95)}{0.070375(98)} = 2 - 0.1448(15)\,, \tag{40}$$

$$\mu = 105.658367(4)\mathrm{MeV}/c^2\,, \tag{41}$$

$$\frac{3}{2}\mu^2_{\mu} = \exp\left(\frac{-2}{3\alpha}\right) \times (1 - 0.467242(53))\,, \tag{42}$$

or

$$\left(\frac{3}{2} + \frac{4}{3}\right)\mu^2_{\mu} = \exp\left(\frac{-2}{3\alpha}\right) \times 1.00632(10)\,, \tag{43}$$

$$K^{\pm} = 493.677(16)\mathrm{MeV}/c^2\,, \tag{44}$$

$$\frac{3}{2}\mu^2_{(K^{\pm})} = \exp\left(\frac{-2}{3\alpha}\right) \times (12 - 0.3692(19))\,, \tag{45}$$

♯ If this was not true, the example with the photonic rocket would used also photons in the opposite direction for the braking effect.

$$K^0 = 497.614(24)\mathrm{MeV}/c^2\,, \tag{46}$$

$$\frac{3}{2}\mu^2_{(K^0)} = \exp\left(\frac{-2}{3\alpha}\right) \times (12 - 0.1830(23))\,, \tag{47}$$

$$\frac{0.3692(19)}{0.1830(23)} = 2 + 0.018(24)\,. \tag{48}$$

The ratio is very close to 2. At the pions this ratio is not so close, but it approaches to the same integer number, 2.

$$p = 938.272013(23)\mathrm{MeV}/c^2\,, \tag{49}$$

$$\frac{3}{2}\mu^2_p = \exp\left(\frac{-2}{3\alpha}\right) \times 42.0126(42)\,, \tag{50}$$

$$\chi_{c1}(1P) = 3510.66(7)\mathrm{MeV}/c^2\,, \tag{51}$$

$$\frac{3}{2}\mu^2_{\chi_{c1}(1P)} = \exp\left(\frac{-2}{3\alpha}\right) \times 588.17(8)\,, \tag{52}$$

$$\left(\frac{\chi_{c1}(1P)}{p}\right)^2 = 14 - 0.00026(56)\,. \tag{53}$$

The above ratio of the squares of the masses $\chi_{c1}(1P)$ and proton is the closest to integer of all combinations of pairs of particles. Probability for accident is possible to calculate after longer procedure.†† Admittedly, it is true that this was obtained without a clear beforehand hypothesis. However, it is not easy to prove that it is obtained without the beforehand hypothesis. What, if it is a sense to say that there is 0.8 part of hypothesis. This statistical law about hypothesis is not yet a finished natural mathematical law. It needs corrections. For instance, a human being finds a lot of things statistically. (Everything is statistics.) Indeed, 100% hypoteses are not always used. Anyway, I hope that the above ratio is much better than statistically expected. Besides I hope that there is still another ratio which is much better than statistically expected. This second one means that the good result will be obtained after a clear 100% hypotesis.

The minimal mass for the heaviest neutrino (let us say this $\nu_{\max-}$) equals $0.04\mathrm{eV}/c^2$ [21, 22]

$$\ln(\mu^2_{\nu_{\max-}}) \times \alpha = -(1 - 0.0091532(7))\,. \tag{54}$$

It can be expected that the masses of all neutrinos are not very different (the difference is maybe smaller than, let us say, for a factor 100). Besides, because the other two masses are smaller, this deviation is still smaller.

††Truly, it is not yet calculated, because the problem is that it is necessary to respect that some particles form pairs or triplets and their accidental mass cannot be calculated independently. If we accept this rule, this means a better result. Besides, 14 equals 42/3.

If we calculate with the above limit (let us name it ν_{max+}) 0.4 eV$/c^2$ for the heaviest neutrino, we obtain:

$$\ln(\mu^2_{\nu_{\max+}}) \times \alpha = -(1 - 0.0427588(7))\,. \tag{55}$$

For instance, for comparison of largeness, we obtain for the electron:

$$\ln(\mu^2_e) \times \alpha = -(1 - 0.24796635(73))\,. \tag{56}$$

Even for the age of universe, according to Planckian time, we get the similar formula as for neutrinos:

$$t_{\text{universe}} = 13.73(12)10^9\text{years}\,, \tag{57}$$

$$t_{\text{Planck}} = 5.3906(40)10^{-44}\text{s}\,, \tag{58}$$

$$\ln\left(\frac{t_{\text{universe}}}{t_{\text{Planck}}}\right) \times \alpha = 1 - 0.027022(96)\,. \tag{59}$$

Something connected with $\exp(\alpha)$ and the universe was also obtained by Dirac.

It is estimated for the cosmological constant Λ that its largeness is roughly close to 10^{-47}GeV^4 [23, 24]. If we respect, that reduced Planckian mass $m_{\text{Pl\_R}}$ is:

$$m_{\text{Pl\_R}} = 2.43 \times 10^{18}\text{GeV}/c^2\,, \tag{60}$$

then it can follow

$$\ln\left(\frac{\sqrt{\Lambda}}{m^2_{\text{Pl\_R}}}\right) \times \alpha = -1.013\,. \tag{61}$$

Thus, although the above deviations are not very small, they can be important, because if factors $\exp(-3/(4\alpha))$ and $\exp(-2/(3\alpha))$ are important, it should be suspected that the factor $\exp(-1/\alpha)$ can also be important.

(i) The pions, as the lightest hadrons, have factor close to 1, therefore they behave similarly as elementary hadrons.

(ii) The muon mass is close to the masses of the pions. Maybe, this is only an accident, we do not know. However, this is a fact, which was noticed after formulae were found.

(iii) The formula for the proton has the factor very close to integer.

(iv) Ratio of the squares of the masses $\chi_{c1}(1P)$ and p is very close to integer, the closest of all such ratios of all known particles.

(v) Because exponents $3/(4\alpha)$ and $2/(3\alpha)$ were found, we can legitimately ask ourselves, if formulae with an exponent close to $1/\alpha$ exist. An inquiry showed that they exist.

(vi) There are still some interesting formulae.

7. Arguments and counter-arguments

Some useful agreements of these formulae are listed below. At the end, weak properties of these formulae are given.

(i) Formulae are symmetric for masses of particles, and they are symmetric for minus and plus charge.†

(ii) Because μs are dependent from α, the formulae mean a reduction of independent physical parameters. The main successful physical theories were based on a reduction of number of independent parameters.

(iii) The formulae show that an increase of charge means an increase of mass. Because the main part of particles have the same absolute largeness of charge, it can be supposed that the charge causes the masses of the particles. (Although there is a lot of particles without charge, I suppose that those particles are implicitly connected with the elementary charge.)

(iv) It is naturally that elementary particles are built up with the help of gravity, because themselves are building blocks of space-time.

(v) The foundations of quantum gravity are μs and black holes.

(vi) The dimensionless nature of μs is also important. Therefore μs can be fundamental quantities.

(vii) Small black holes are important, because they are the best tool for G measurement. The existence of physical quantities is conditioned with tools for measurements of them.

(viii) By a general opinion, the lightest black hole mass equals approximately $m_{\rm pl}$. However, this disturbs continuity among theories in different areas of physics. This also disturbs simplicity of physical theories.

(ix) The formulae alone suggest the model, how black holes with mass smaller than $m_{\rm pl}$ can exist. It is a model which can survive without my formulae.

(x) It can be expected that quantum self-gravitational energy is not time constant. The electron formula (7) offers a model for variation of self-gravitational-energy. This is a theory, which can be developed and checked.

(xi) The interpretation of the formulae shows more clearly, how the principle of uncertainty, which is good for a location x and a momentum p, is not good for a rest energy.

(xii) The electron formula (7) gives a model with a maximal entropy.

(xiii) The interpretation of the formula (7) gives that gravity is only attractive and mass is only positive, what is satisfactory. Thus, in quantum physics we do not jump

† Although rather imprecise, the measurements of the neutrino and antineutrino mass differences show, that these masses are not equal. However, this is against the principles of special relativity theory [25, 26, 27].

into something completely different according to the classical physics. This was explained with properties of uncertainty of energy.

(xiv) Self-gravitational energy and a particle mass are proportional.

(xv) Gravity is an interactional phenomenon. Therefore, formula a for μ_e^2 is more essential than the formula for μ_e. This also means that the first non-zero mass level is $4m_{\rm pl}^2/(3m_e)$ and not only $m_{\rm pl}$. The Shannon Entropy of a single bit is zero [5]. The most probably, an elementary particle owns its own information, not only information in interactions with other particles.

(xvi) The entropy is the only known indicator of time arrow.‡ This is mentioned for entropy of group of elementary particles. The most fundamental element, where time runs, is an elementary particle. So we need more fundamental entropy and this is entropy of an elementary particle. At the same time this answers on the known paradox, why entropy exists for a black hole, although it is not build up from smaller elements.

(xvii) Formula (1) and its analogous form for pions (36) were obtained only in one hour on a calculator. Thus, it is not possible to say: "because you tried a lot, you can obtain a lot of precise and simple formulae".

(xviii) When it was found that the same factor should stand before μ^2 as before α, formulae for the electron and the pions were essentially improved. A factor in the formula for the proton remains close to a integer (from 28 to 42).

(xix) Electron formula (7) is very similar to the formula for the Hawking radiation (32) and to formula for average energy of harmonic oscillator (10). This similarity was found after the formula (7) was found. Even hs occupied the right places. It is also an achievement that some accidental formulae can be physically interpreted. This similarity also gave a credible model for formula (7).

(xx) The electron formula (7) is similar to formula (9), although I obtained (7) before I learned for (9).

(xxi) The interpretation shows an example, how to non-trivially test Duff's ideas [11, 12]. His ideas are important because they reduce number of physical parameters.

The weak points of my formulae are

(i) The idea about the pion as an elementary hadron disagrees with measurements. Maybe the Higgs boson and a new less mysterious interpretation of quarks will seal this disagreement. Of course, this is not a problem of formulae (1) do (9).

(ii) All aspects of formulae are not yet explained. This means factors 4/3, 3/2, the connection with fine structure constant, etc.

(iii) The absence of a part analogous to $h\nu/2$ is not enough clearly explained. But, a further clarification of this is possible.

‡ Let us assume that we have two persons which live in opposite time directions. They exchange one photon. But both really emit it or receive it, it is not unequivocally. So entropy, or divergent ray of light, is the only indicator of real time arrow.

(iv) The value of the fine structure constant at momentum zero is only used. Although this seems inappropriate, the fine structure constant should be connected with the masses of the elementary particles, because of a reduction of number of independent physical parameters. Then we ask ourselves, value at which momentum is the most fundamental. It is not known any other more important value of momentum of the fine structure constant than at zero momentum.

(v) The fine structure constant varies at continuous values, whereas μ_e varies only at integer values of $4\mu_e\langle\mu_e\rangle/3$.

(vi) It is not yet clearly known, how to ignore a frequency of harmonic oscillator and a radius of the black hole without care, because it is expected that they should exist in such a formulae.

8. Conclusion

The empirical formulae for the masses of elementary particles were found some years ago. After this a physical interpretation of these formulae was made and possible physical model is offered. A Many arguments for formulae is also presented here.

This theory can also be tested. One possibility is to measure gravitational constant more precisely. If nothing more, guessworks of further formulae could be more precise.

The eventual variation of elementary constants with time [28, 29] can be compared with these formulae. Maybe the masses of the particles are dependent from α.

As third, it is possible a theoretical development of some ideas in the article. It is possible to study, how to make the most precise theoretical measurement of G.

Many ideas, about whose it is possible to speak, is here.

The purpose of this article is to defend the formulae, whereas not at any price. The second purpose is also to collect all ideas about these formulae, and thus to obtain new ideas easier. Therefore some sentences are added, whose are not completely consistent with the motto of the article. The third purpose is to come to public and to hear new arguments and counter-arguments, to increase my knowledge and to test ourselves, how I am possible to answer on these ideas. The problem of such theories is that they are rather ignored and therefore there is not enough progress at clarification of such theories. The present scientific system of publications is not yet enough sophisticated to give this possibility. Although arguments and counter-arguments can give a lot of clarifications and new ideas, they must begin somewhere. Scientist are also not aware, that uncompleted theories can also be sources of useful information.

Otherwise, today it is a negative standpoint about such theories. It is an opinion that such theories are not even speculations, but absolutely without any possibility for any positive result. Indeed, Balmer's series of the hydrogen spectrum was found on this way. Although the statistical theory about hypotheses is not yet clear enough, all mathematicians think that it is. Something about this is also written in the article.

The future final theory of quantum gravity, any type it will be, will explain the masses of elementary particles, space, time, physical information given by those elements, therefore almost everything. Of course, this is not completely everything. However, we are not enough aware that quantum mechanics will not be a self-consistent theory, until quantum gravity theory will not be known.

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