The Code of Nature

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Abstract. The scope of the work described in this paper is a systematic investigation as to whether or not the mass of the proton and the electron can be represented by other fundamental constants. The author arrives at the conclusion that the mass of the proton and the electron can be expressed by a combination of five constants that occur in nature; namely, e, ε_o, h, c, G, plus a time-variable parameter. In this context, the author has studied more than 37,000 options using electronic support and powering the fundamental constants with natural numbers only.

The simplest and most convincing formula the author has found is:

$$m_e^3 \times m_p^3 = (e^2\, h/4\pi\, \varepsilon_o\, c\, G\, R)^2$$

This equation results in the exact value of the mass of the proton and the electron. The beauty and simplicity of this equation give rise to the following question: What, if not this formula, is able to represent the mass of the two most important particles?

The author's conclusion is that either the electron and proton masses themselves are natural constants that cannot be represented by other constants of nature, or that – as shown in this paper – they can be perfectly well represented by five other fundamental constants, in addition to a time-variable parameter.

Electron m_e

Proton m_p

$$m_e^3 \times m_p^3 = (e^2 h / 4\pi \varepsilon_o c G R)^2$$

Introduction.

The question of whether humans will ever have a complete understanding of the rules and laws of nature cannot be fully answered at this point. History shows, however, that science is little by little succeeding in understanding more and more of nature. A self-confessed optimist in this regard, the author believes that this development will also continue in future.

As the current state of physics shows, many questions are still open. For example, there is at present no uniform description of the fundamental forces of nature, nor has anybody been able to explain the measured masses of the elementary particles.

In the so-called Standard Model of particle physics which currently represents the generally recognised state of physical knowledge, masses of elementary particles are input parameters. The standard model can therefore describe the "family tree" of elementary particles, but is unable to explain it further.

If, in line with the author, we assume that nature is based on laws that could potentially be understood by mankind, we are sure to crack these as yet secret natural codes eventually and piece by piece, just as hackers always manage to overcome seemingly insurmountable barriers.

What are the basic elements of this natural code; the natural equivalents of the bits and bytes in computer science? Of course, it is entirely conceivable that nature consists of elements that are similar to bits and bytes. However, we are currently nowhere near a point where we could confidently make such a judgment. The physical constants are probably not as fundamental as bits and bytes, but they are likely to contain very basic information about the code of nature. Somehow, they seem to be words or letters written in the code of nature.

Constants of nature show us basic quantitative relationships between physical quantities. The gravitational constant, for example, shows us how masses and forces are coupled. This information is included in the value of the gravitational constant on the one hand (6.67×10^{-11}) and in its dimension (m^3/kgs^2) on the other.

The question is: Which are the fundamental constants of nature that cannot be represented by others and which constants are not fundamental and may be represented by others? For example, it is unclear whether the measured masses of the elementary particles such as the mass of protons and electrons are mathematically represented by other constants of nature or whether they themselves are constants of nature and thus one of the fundamental constant parameters of our universe.

If the mass of the proton and the electron can be represented by other fundamental constants, then their natural code should in principle be crackable by systematic investigation, simply through the clever combination of constants of nature to masses.

This method, normally used for decrypting or hacking, is indeed an unusual tool in physics, but that is no plausible argument not to use it. The unconventional is always justified in cases where the conventional has so far yielded no success.

Investigation:

Which natural constants, then, are able to deliver the SI-unit kg? Three of the fundamental constants are eligible:

- First, the gravitational constant $G = 6.67384 \times 10^{-11}\ m^3/kgs^2$, which describes the strength of gravity.
- Second, Planck's constant $h = 6.62606957 \times 10^{-34}\ kgm^2/s$, which, loosely speaking, provides the basic portioning of energy (quantum).
- Third, the vacuum permittivity or electric field constant $\boldsymbol{\varepsilon_o} = 8.85418781762 \times 10^{-12}\ A^2s^4/kgm^3$, which describes the strength of the electromagnetic force.

Which natural constants are suitable for eliminating the SI units m (meter), s (seconds) and A (Ampere)? The speed of light $c = 2.99792458 \times 10^8$ m/s and the elementary electric charge $e = 1.602176565 \times 10^{-19}$ As are both eligible.

With the five fundamental constants, two masses may be represented relatively easily. One is the so-called Planck mass $m_{pl}^2 = hc/G$. Its value is 5.4557×10^{-8} kg. It marks to some extent the upper limit of the possible particle masses, since their Compton wavelength $\lambda = h/cm_{pl}$ is identical with the Planck length $l_{pl}^2 = Gh/c^3$, which is currently the smallest meaningful unit of length in physics.

The other is a type of mass equivalent to the unit charge $m_{eq}^2 = e^2/4\pi\boldsymbol{\varepsilon_o}G$. Its value is 1.8593×10^{-9} kg. It shows how heavy two masses have to be for attracting each other gravitationally as strongly as a positive and negative unit would do through electromagnetic force in a vacuum at the same distance.

We get masses by combining h and G (using c) or $\boldsymbol{\varepsilon_o}$ and G (with the aid of e). What can we get with h and $\boldsymbol{\varepsilon_o}$? With h and $\boldsymbol{\varepsilon_o}$ and by using c and e we arrive at a dimensionless number $x = e^2/\boldsymbol{\varepsilon_o}ch = 2/137.036$. This number is twice of what in physics is known as the fine structure constant α, whose value is 1/137.036.

If we assume that the masses of the elementary particles are derivable from the fundamental constants G, h, $\boldsymbol{\varepsilon_o}$, c and e, then the corresponding functions could have the following structures:

either:

$$m_{particle}^{2n} = \alpha^{y} \times m_{pl}^{2n} = \alpha^{y} \times (hc/G)^n,$$

or:

$$m_{particle}^{2n} = \alpha^{z} \times m_{eq}^{2n} = \alpha^{z} \times (e^2/4\pi\boldsymbol{\varepsilon_o}G)^n$$

with n, y and z being dimensionless numbers.

However, obtaining the exact value of the mass of for instance an electron in this manner requires very large integers for n, y and z, or numbers with multiple digits. Overall, this approach seems less than convincing.

The case becomes more interesting when we add an additional parameter to the five fundamental constants, which depends on the age of the universe. The currently most accepted cosmological model, the so-called Lambda-CDM model, supposes the age of the universe to be $13.73\ _{-0.17}\ ^{+\ 0.13}$ billion years. This age, multiplied by the speed of light, gives a radius of 13.73 billion light years according to the radius of the observable universe. CDM stands for Cold Dark Matter.

Supporters of the theory of inflation and standard cosmology will argue that the radius of the visible universe is more than the distance of 13.73 billion light years. This does not constitute a problem in as far as we may substitute the radius R simply by the term cT (the speed of light x age of the universe). The numerical result is the same, but the interpretation is different.

Followers of the standard model can interpret the temporal change of the particle mass as a consequence of age-dependent "dissipation" or "mass reduction". Followers of alternative cosmological theories may see the universe as an interconnected entangled whole, a kind of black hole with radius $R = (2)GM/c^2$, which is growing at the speed of light. They will explain the reduction of elementary masses by the expansion of the universe and its space, thereby decreasing the (average) energy density of the universe.

The considerations made by Carl Friedrich von Weizsäcker led the author towards the idea of using an additional parameter. As part of his so-called *Urhypothese,* he has indicated a probable relationship between the radius of the visible universe and the proton mass expressed as the Compton wavelength λ_p of the proton being an approximate function of R (where l_{pl} is the Planck length) :

(1) $\lambda_p \approx l_{pl}^{2/3} \times R^{1/3}$ or $\lambda_p^3 \approx l_{pl}^2 \times R$

(In this context, cf. also:
Lutz Castell, Otfried Ischebeck: Time, Quantum and Information. Springer-Verlag Berlin Heidelberg 2003, page 365.)

Using the radius of the visible universe (or the product cT) and the five fundamental constants described above, the author conducted a systematic dimensional analysis using electronic support. In this context, more than 37,000 options were studied by powering the fundamental constants only with natural numbers.

Unlike in the author's previous work "Über den Zusammenhang von Elementarteilchenmassen und Naturkonstanten" (On the Relation of Elementary Masses and Fundamental Constants) from April 2008, not only the value of the electric field constant $\varepsilon_o = 8.85418781762 \times 10^{-12}\ A^2s^4/kgm^3$ was used, but the value of the electric field constant ε_o was multiplied by 4π, which corresponds to the reciprocal value of the so-called Coulomb constant.

It is precisely this "little" difference that was found to be the key to success. In a graphic representation of the more than 37,000 options, a convergence of values was noted, tending towards the formula

(2) $m_x^3 = e^2 h/4\pi\, \varepsilon_o\, c\, G\, R$ (or $e^2 h/4\pi\, \varepsilon_o\, c^2\, G\, T$)

The square m_x^2 of the unknown mass m_x resulting from formula (2) is exactly the same as the product $m_e \times m_p$ of the electron mass and the proton mass, so that equation (2) can be transformed into:

(3) $m_e^3 \times m_p^3 = (e^2 h/4\pi\, \varepsilon_o\, c\, G\, R)^2$

Formula (3) is fascinating in its simplicity in as far as it powers constants and masses with very small natural numbers, but still represents the values of the electron and proton mass with sufficient exactness as well as containing the structure of the assumption (1) made by Weizsäcker.

Putting the exact values of m_e, m_p, e, ε_o, c, h und G in (3), we obtain a value of R = 1.285 x 10^{26} m, corresponding to 13.59 billion light-years or an age of the universe of 13.59 billion years. This value is within the limits of accuracy of $13.73_{-0.17}^{+0.13}$ billion years of the Lambda-CDM model.

Equation (2) can be transformed into

(4) $m_x^3 = (e^2/4\pi\, \varepsilon_o\, c\, h) \times (h^2/G\, R) = \alpha/2\pi \times (h^2/G\, R)$

Considering $\lambda_p = h/cm_p$ and $l_{pl}^2 = Gh/c^3$ we can transfer (1) into formula

(5) $m_p^3 \approx h^2/G\, R$

It will be noted that (2) or (4) include Weizsäcker's assumption, formulated in (1) or (5).

The beauty and simplicity of equation (2) - $m_x^3 = e^2 h/4\pi\, \varepsilon_o\, c\, G\, R$ - give rise to the question of what meaning this as yet unknown mass itself could have? Its value, if R = 1.285 x 10^{26} m or T = 13.59 billion years is 3.9034 x 10^{-29} kg or 21.90 MeV.

If such a mass with charge exists, it should occur by pairing oppositely charged particles in high-energy processes, similar to electron-positron pairs being formed where sufficient energy levels exist. Conversely, if such masses and anti-masses would meet, they would immediately dissolve into energy through pair annihilation. It is therefore assumed that particles with such a mass - if they exist – do not have charges, otherwise they would surely have been discovered already.

Rather, the author suggests that particles with a mass of 21.9 MeV exist that interact only gravitationally (and weakly) with ordinary matter and are representatives of the so-called dark matter. According to the standard model of cosmology, about 23% of the universe is assumed be dark matter. The as yet unknown particles should play their part in processes with temperatures around 250 billion degrees Kelvin, scales at 5 x 10^{-14} m and densities of around 4 x 10^{11} kg/m^3.

Such conditions would most likely not have existed for just a short time after the Big Bang, but should also exist in galactic and possibly even stellar mass concentrations of sufficient scope.

Even if no such masses can be confirmed experimentally, rendering equation (2) irrelevant, this would in no way detract from the startling evidence of relationship (3), which would require a separate falsification. Conversely, the confirmation of equation (2) would result in a strong indication of the validity of (3), although this would also require a separate confirmation.

The falsification of a relationship of the type

(6) $m_e^x = f(1/R)$ with $x \approx 3$ and/or $m_e^x = f(1/T)$ with $x \approx 3$

as following from equation (3), where m_p is replaced by 1836.15 x m_e, is dealt with in the author's previous work "Über den Zusammenhang von Elementarteilchen und Naturkonstanten" (1836.15 is known, the ratio of proton to electron mass), where it is shown that such a function causes a time variation of the so-called Rydberg frequency, describing the light emission of hydrogen according to:

(7) $\nu = (1/n^2 - 1/m^2) \times \nu_R$

ν is the frequency of the light when the electron of the hydrogen changes from the m^{th} to the n^{th} energy level. ν_R is the Rydberg frequency.

(8) $\nu_R = m_e e^4/8\varepsilon_o^2 h^3 = 3.2898 \times 10^{15}\ s^{-1}$

ν is thus directly proportional to m_e. What does this mean?

The following table shows the values of m_e/m_{ep} as a function of R/R_p according to formula (6), with m_{ep} and R_p as the values of m_e and R at the present time.

Table 1

R/R_p	0.1	0.25	0.5	0.75	1	1.25	1.5	1.75	2
(6)	2.15	1.59	1.26	1.10	1	0.93	0.87	0.83	0.79

A look at table 1 provides immediate clarity. It applies not only to the ratio of m_e/m_{ep} but also of ν/ν_p . This means that in earlier times, the frequency of the emitted light would have been higher than today, which should entail a blue shift in the light when we look at the past, i.e. when we observe distant galaxies.

This blue shift would have to be subtracted from the red shift induced by the expansion of the universe. The distances in the universe would consequently be a little larger than our calculations based exclusively on red shift. Such a blue shift proportion of distant supernovae could make us believe that the universe is expanding at an accelerated rate, although in fact the deviations from linearity are caused by the time variation of the electron mass. However, this accelerated expansion of the universe is at present widely recognised among cosmologists.

Let us therefore conclude:

The present results suggest that the fine structure constant α and thus e, ε_o, h, and c that make up α are constant in time. Otherwise, we would have to assume that subtle contrary temporal developments of two or more of the constants e, ε_o, h or c exist in order to achieve constancy with the constant measured level of α. Currently, there are also no hard facts that speak against the constancy of the gravitational constant G, so that (for now) we have to work with a constant value of all five mentioned constants.

As the author has systematically investigated, the value of the electron and proton mass cannot be represented in a convincing manner by the five used constants of nature e, ε_o, h, c and G alone. To do this, the five constants would have to be powered by "unnaturally" high integers or real numbers with multiple digits.

Either the electron and proton masses themselves are natural constants, which cannot be represented by other constants of nature, or they are, as shown in the present paper, very well represented by other fundamental constants, plus a time-variable parameter. Such a time-variable parameter would either have to be radius R of the visible universe, or, alternatively, the age of the universe. The ease and simplicity of the relationship the author has found in

$m_e^3 \times m_p^3 = (e^2\, h/4\pi\, \varepsilon_o\, c\, G\, R)^2$

speaks for the latter. If the universe is based on a "code" with a few fixed values, then the relation found for the two masses should be part of this "code". The decryption of the complete code of nature - if it lies within the intellectual scope of man - requires further investigation.

Efforts in this regard should be well worth the hard work they will require. What could be more thrilling than to crack the code according to which all of nature and we ourselves are "written"? Such efforts must be driven by the age-old, irresistible urge to learn more about our environment and ourselves.