Theoretical determination of fundamental physical constants

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The article presents a theoretical method of determination of fundamental physical constants. The results of analytical calculations, including: the fine structure constant, the wave length of Compton, the electron mass, elementary charge, Planck constant, Planck mass, length and time, Planck, Newton's gravitational constant, the lifetime of the neutron.

Keywords: the fine-structure constant, the wave length of Compton, the electron mass, elementary charge, Planck constant, Planck mass length and time, Newton's gravitational constant, the lifetime of the neutron, the baryon asymmetry of the Universe

Notes:
If the parameter has a subscript « π » means that this theoretical parameter has a numeric value that can be used instead of the true parameter value.
Used measurement units: length $\mathrm{u}_{\pi l}=1{,}0[\text{см}]$, mass $\mathrm{u}_{\pi m}=1{,}0[\text{г}]$, time $\mathrm{u}_{\pi t}=1{,}0[\text{c}]$ and the surface density of mass $\mathrm{u}_{\pi\rho S}=\dfrac{\mathrm{u}_{\pi m}}{\mathrm{u}_{\pi l}^2}$ of the Unitary of system of units.

1. The basic relationships

Let us write the expression

$$k_{\pi 0}^{n-1}\cdot\lambda_\pi\cdot(1\pm\vartriangle y_\pi\cdot\alpha_\pi)^n=(\sqrt{2}\cdot\pi)^n\cdot\lambda_{\pi 0}^n, \tag{1.1}$$

Where

$$k_{\pi 0}=\lambda_\pi\cdot\alpha_\pi\cdot\beta_\pi;\ \lambda_{\pi 0}^n=\pi^{n-1}\cdot k_{\pi 0}^n; \tag{1.2}$$

α_π, β_π, $\vartriangle y_\pi$ – numeric parameters; λ_π, $k_{\pi 0}$, $\lambda_{\pi 0}$ – the parameters with dimension of length; $n=1, 2, 3, \ldots$ – integer from natural number.
It is known [1, p. 37] algebraic equation with an unknown x degree n type:

$$f(x)\equiv a_0\cdot x^n+a_1\cdot x^{n-1}+\cdots+a_{n-1}\cdot x+a_n=0 \qquad (a_0\neq 0). \tag{1.3}$$

Here n – non-negative integer, a_0, $a_1,\cdots$, a_n – is a real numbers, $f(x)$ – the polynomial [2, p. 7] extent n on one variable x:

$$f(x)=(1+x)^n=1+n\cdot x+\frac{n\cdot(n-1)}{2!}\cdot x^2+\frac{n\cdot(n-1)\cdot(n-2)}{3!}\cdot x^3+\ldots+\frac{n!}{(n-r)!\cdot r!}\cdot x^r+\ldots. \tag{1.4}$$

$$f(x)=(1-x)^n=1-n\cdot x+\frac{n\cdot(n-1)}{2!}\cdot x^2-\frac{n\cdot(n-1)\cdot(n-2)}{3!}\cdot x^3+\ldots+(-1)^r\cdot\frac{n!}{(n-r)!r!}\cdot x^r+\ldots \tag{1.5}$$

If n – positive integer, the expressions (1.4) and (1.5) consists of a *finite number* of members.
The algebraic equation of the form (1.3) is called valid if all its coefficients a_i – are real numbers. It is known [1, p. 39] that the corresponding equation (1.3) is a valid polynomial $f(x)$ of the form (1.4) and (1.5) for all valid values x can take values. In the article are only valid algebraic equation of the form (1.3).
We write (1.1) in the form

$$\frac{(1\pm\vartriangle y_\pi\cdot\alpha_\pi)^n}{(\sqrt{2}\cdot\pi)^n}\cdot k_{\pi 0}^{n-1}\cdot\lambda_\pi=\lambda_{\pi 0}^n. \tag{1.6}$$

We denote the left part of equation (1.6) as

$$\lambda_{\pi S}^{n-1}=\frac{(1\pm\vartriangle y_\pi\cdot\alpha_\pi)^n}{(\sqrt{2}\cdot\pi)^n}\cdot k_{\pi 0}^{n-1}, \tag{1.7}$$

then (1.6) can be written:

$$\lambda_{\pi S}^{n-1}\cdot\lambda_\pi=\lambda_{\pi 0}^n. \tag{1.8}$$

Taking into account (1.2), the expression (1.7) can be written as

$$\lambda_{\pi S}^{n-1} = \frac{(1 \pm \vartriangle y_\pi \cdot \alpha_\pi)^n \cdot (\alpha_\pi \cdot \beta_\pi)^{n-1}}{(\sqrt{2} \cdot \pi)^n} \cdot \lambda_\pi^{n-1}. \tag{1.9}$$

At the same time, taking into account (1.2) and (1.8) $\lambda_{\pi S}^{n-1}$ can be written in the form

$$\lambda_{\pi S}^{n-1} = \pi^{n-1} \cdot (\alpha_\pi \cdot \beta_\pi)^n \cdot \lambda_\pi^{n-1}. \tag{1.10}$$

Equating (1.9) and (1.10), we obtain:

$$(\sqrt{2} \cdot \pi)^n \cdot \pi^{n-1} \cdot \alpha_\pi \cdot \beta_\pi = (1 \pm \vartriangle y_\pi \cdot \alpha_\pi)^n. \tag{1.11}$$

It is known [1, p. 38] that a general formula expressing the roots of algebraic equations through the coefficients and containing only a *finit*e *number* of operations, additions and subtractions, multiplications, divisions and root extractions only exist for equations of degree $n \le 4$. With this in mind, we write the equation (1.1) for the case $n = 3$ in the form of:

$$k_{\pi 0}^2 \cdot \lambda_\pi \cdot (1 \pm \vartriangle y_\pi \cdot \alpha_\pi)^3 = (\sqrt{2} \cdot \pi)^3 \cdot \lambda_{\pi 0}^3, \tag{1.12}$$

then $\lambda_{\pi 0}^n$ from (1.2) can be written as

$$\lambda_{\pi 0}^3 = \pi^2 \cdot k_{\pi 0}^3, \tag{1.13}$$

and (1.6) as

$$\frac{(1 \pm \vartriangle y_\pi \cdot \alpha_\pi)^3}{(\sqrt{2} \cdot \pi)^3} \cdot k_{\pi 0}^2 \cdot \lambda_\pi = \lambda_{\pi 0}^3. \tag{1.14}$$

Designating the area s_π as

$$s_\pi = \frac{(1 \pm \vartriangle y_\pi \cdot \alpha_\pi)^3}{(\sqrt{2} \cdot \pi)^3} \cdot k_{\pi 0}^2, \tag{1.15}$$

we write (1.14), taking into account (1.15), as

$$s_\pi \cdot \lambda_\pi = \lambda_{\pi 0}^3. \tag{1.16}$$

Taking into account (1.2), (1.15) can be written as

$$s_\pi = \frac{(1 \pm \vartriangle y_\pi \cdot \alpha_\pi)^3 \cdot (\alpha_\pi \cdot \beta_\pi)^2}{(\sqrt{2} \cdot \pi)^3} \cdot \lambda_\pi^2. \tag{1.17}$$

At the same time, taking into account (1.2), (1.13) and (1.16), the area s_π can be written as

$$s_\pi = \pi^2 \cdot (\alpha_\pi \cdot \beta_\pi)^3 \cdot \lambda_\pi^2. \tag{1.18}$$

Let us denote in (1.18) elementary scalar radius $r_{\pi s}$ as

$$r_{\pi s} = \alpha_\pi \cdot \beta_\pi. \tag{1.19}$$

scalar the length of a circle $l_{\pi s}$, given (1.19), equal

$$l_{\pi s} = 2 \cdot \pi \cdot \alpha_\pi \cdot \beta_\pi \tag{1.20}$$

and the scalar square $s_{\pi s}$ is equal to

$$s_{\pi s} = 4 \cdot \pi^2 \cdot r_{\pi s}^2, \tag{1.21}$$

scalar volume $v_{\pi s}$:

$$v_{\pi s} = \pi^2 \cdot r_{\pi s}^3. \tag{1.22}$$

Equating (1.17) and (1.18), we obtain the equation:

$$(\sqrt{2} \cdot \pi)^3 \cdot \pi^2 \cdot \alpha_\pi \cdot \beta_\pi = (1 \pm \vartriangle y_\pi \cdot \alpha_\pi)^3. \tag{1.23}$$

2. Protoparameters

2.1. Scalar parameter of structure of space-time

We write the equation (1.23) in the form

$$(\sqrt{2}\cdot\pi)^3\cdot\pi^2\cdot\alpha_{\pi0}\cdot\overline{\beta}_\pi=(1+\vartriangle y_\pi\cdot\alpha_\pi)^3, \tag{2.1.1}$$

where:

$$\overline{\beta}_\pi=1+\overline{\beta}_{\pi0}; \tag{2.1.2}$$

$$\vartriangle y_{\pi0}=\sqrt[4]{2\cdot\pi}; \tag{2.1.3}$$

$$\varphi_{\pi0}=\frac{\alpha_{\pi0}}{\overline{\beta}_{\pi0}},\ (\varphi_{\pi0}=\sqrt{2}\cdot\pi). \tag{2.1.4}$$

The right part of (2.1.1) is a polynomial (1.4) for the case of $n=3$ [2, p. 8]:

$$(1+x)^3=1+3\cdot x+3\cdot x^2+x^3. \tag{2.1.5}$$

Denoting $x=\vartriangle y_{\pi0}\cdot\alpha_{\pi0}$, we write (2.1.5) as

$$(1+\vartriangle y_{\pi0}\cdot\alpha_{\pi0})^3=1+3\cdot\vartriangle y_{\pi0}\cdot\alpha_{\pi0}+3\cdot\vartriangle y_{\pi0}^2\cdot\alpha_{\pi0}^2+\vartriangle y_{\pi0}^3\cdot\alpha_{\pi0}^3. \tag{2.1.6}$$

Equation (2.1.5) is written in general form as [3, p. 304]:

$$a\cdot x^3+b\cdot x^2+c\cdot x+d=0 \qquad (a\neq 0). \tag{2.1.7}$$

Using any of the known methods for solving cubic equations (for example, the solution of Cardano [1, p. 43] or search procedure – for example, a method of half division [3, p. 472]) yields the parameter $\alpha_{\pi0}$ – is the real root of the equation (2.1.1).

We write the equation (1.23) in the form:

$$(\sqrt{2}\cdot\pi)^3\cdot\pi^2\cdot\alpha_{\pi e}\cdot\beta_{\pi e}=(1-\vartriangle y_{\pi e}\cdot\alpha_{\pi e})^3, \tag{2.1.8}$$

in which the parameter $\beta_{\pi e}$

$$\beta_{\pi e}=1+\frac{\overline{\beta}_{\pi0}}{\overline{\beta}_\pi^3}. \tag{2.1.9}$$

Right hand side of (2.1.8) is a polynomial (1.5) for the case of $n=3$ [2, p. 8]:

$$(1-x)^3=1-3\cdot x-3\cdot x^2-x^3. \tag{2.1.10}$$

Denoting $x=\vartriangle y_{\pi e}\cdot\alpha_{\pi e}$, we write (2.1.10) in the form

$$(1-\vartriangle y_{\pi e}\cdot\alpha_{\pi e})^3=1-3\cdot\vartriangle y_{\pi e}\cdot\alpha_{\pi e}-3\cdot\vartriangle y_{\pi e}^2\cdot\alpha_{\pi e0}^2-\vartriangle y_{\pi e}^3\cdot\alpha_{\pi e}^3. \tag{2.1.11}$$

For finding the coefficient $\vartriangle y_{\pi e}$ in (2.1.11) we write the quadratic equation

$$\frac{1}{\varphi_{\pi0}}\cdot\alpha_{\pi x}^2+\alpha_{\pi x}-\overline{\beta}_\pi=0. \tag{2.1.12}$$

As is known [1, p. 43] an algebraic equation of the 2nd degree is written in the form:

$$a\cdot x^2+b\cdot x+c=0 \qquad (a\neq 0). \tag{2.1.13}$$

The roots of the equation are determined by the formula:

$$x_{1,2}=\frac{-b\pm\sqrt{b^2-4\cdot a\cdot c}}{2\cdot a}. \tag{2.1.14}$$

Note that

$$x_1+x_2=-\frac{b}{a}\ \text{и}\ x_1\cdot x_2=\frac{c}{a}. \tag{2.1.15}$$

The ratio of the roots of equation (2.1.12) we write as:

$$\Delta_{\pi x}=\frac{\alpha_{\pi x2}}{\alpha_{\pi x1}}. \tag{2.1.16}$$

Find $\vartriangle y_{\pi e}$ out how

$$\vartriangle y_{\pi e}=\frac{\Delta_{\pi x}}{\vartriangle y_{\pi0}^3}. \tag{2.1.17}$$

Using any of the known methods of solving cubic equations, or a search procedure, we find the parameter

$\alpha_{\pi e}$ – is the real root of the equation (2.1.8).

For determine the scalar parameter of structure of space-time $\mathrm{f}_{\pi s}$ we write the ratio:

$$\frac{\alpha_{\pi 0}\cdot\bar{\beta}_{\pi}}{\alpha_{\pi e}\cdot\beta_{\pi e}}=\frac{(\alpha_{\pi e}\cdot\beta_{\pi e})^{3}}{(\alpha_{\pi}\cdot\beta_{\pi})^{3}}\,. \tag{2.1.18}$$

Write (2.1.18) in the form

$$(\alpha_{\pi}\cdot\beta_{\pi})^{3}=\frac{\alpha_{\pi e}^{4}\cdot\beta_{\pi e}^{4}}{\alpha_{\pi 0}\cdot\bar{\beta}_{\pi}}\,. \tag{2.1.19}$$

From (2.1.19):

$$\alpha_{\pi}\cdot\beta_{\pi}=\sqrt[3]{\frac{(\alpha_{\pi e}\cdot\beta_{\pi e})^{4}}{\alpha_{\pi 0}\cdot\bar{\beta}_{\pi}}}\,. \tag{2.1.20}$$

Scalar parameter of structure of space-time $\mathrm{f}_{\pi s}$:

$$\mathrm{f}_{\pi s}=\alpha_{\pi}\cdot\beta_{\pi}\,. \tag{2.1.21}$$

2.2. Electromagnetic constant

For determine the electromagnetic constant α_{π} let us write the expression:

$$\frac{[\alpha\cdot\beta]_{\pi}}{\alpha_{\pi 0}\cdot\bar{\beta}_{\pi}}=\frac{(\alpha_{\pi e}\cdot\beta_{\pi e})^{3}}{[\alpha\cdot\beta]_{\pi}^{3}} \tag{2.2.1}$$

Let us write the expression (2.2.1) in the form

$$[\alpha\cdot\beta]_{\pi}^{4}=(\alpha_{\pi e}\cdot\beta_{\pi e})^{3}\cdot\alpha_{\pi 0}\cdot\bar{\beta}_{\pi}\,. \tag{2.2.2}$$

From (2.2.2):

$$[\alpha\cdot\beta]_{\pi}=\sqrt[4]{(\alpha_{\pi e}\cdot\beta_{\pi e})^{3}\cdot\alpha_{\pi 0}\cdot\bar{\beta}_{\pi}}\,. \tag{2.2.3}$$

We denote the relation (2.2.3) to (2.1.20):

$$\mathrm{k}_{\pi}^{4}=\frac{[\alpha\cdot\beta]_{\pi}}{\alpha_{\pi}\cdot\beta_{\pi}}\,. \tag{2.2.4}$$

The ratio k_{π} of (2.2.4):

$$\mathrm{k}_{\pi}=\sqrt[4]{\frac{[\alpha\cdot\beta]_{\pi}}{\alpha_{\pi}\cdot\beta_{\pi}}}\,. \tag{2.2.5}$$

The electromagnetic constant α_{π} is defined as

$$\alpha_{\pi}=\frac{\alpha_{\pi e}}{\mathrm{k}_{\pi}}\,. \tag{2.2.6}$$

3. Fundamental physical constants

From the relation

$$\frac{\lambda_{\pi}^{3}}{2\cdot\pi^{2}\cdot\mathrm{f}_{\pi s}^{3}\cdot\lambda_{\pi}^{2}}=2\cdot\pi\cdot\mathrm{f}_{\pi s}\cdot u_{\pi l} \tag{3.1}$$

find the wavelength of λ_{π}

$$\lambda_{\pi}=4\cdot\pi^{3}\cdot\mathrm{f}_{\pi s}^{4}\cdot u_{\pi l}\,. \tag{3.2}$$

Taking into account (3.2) and the substitution of the fine-structure constant α in the form

$$\alpha_{\pi th}=2\cdot\pi\cdot\alpha_{\pi} \tag{3.3}$$

in the formula for Rydberg constant R_{∞} (represented on the website National Institute of Standards and Technology (NIST) at the address http://physics.nist.gov/cuu/Constants/index.html):

$$\lambda_C / 2\pi = \frac{\alpha^2}{4\pi \cdot R_\infty}, \tag{3.4}$$

we define from (3.4) Rydberg constant $R_{\pi\infty}$ in the form

$$R_{\pi\infty} = \frac{\alpha_{\pi th}^2}{8 \cdot \pi^3 \cdot \mathrm{f}_{\pi s}^4} \cdot u_{\pi l}^{-1}. \tag{3.5}$$

The matching coefficient $k_{\pi R}$ defined as:

$$k_{\pi R} = \frac{R_{\pi\infty}}{\bar{R}_\infty}. \tag{3.6}$$

The wavelength of Compton $\lambda_{\pi \mathrm{C}}$ we find, given (3.6) in the form

$$\lambda_{\pi \mathrm{C}} = k_{\pi R} \cdot \lambda_\pi. \tag{3.7}$$

The mass of an electron $m_{\pi \mathrm{e}}$ find, taking into account (1.18) in the form

$$m_{\pi \mathrm{e}} = \pi^2 \cdot \mathrm{f}_{\pi s}^3 \cdot \lambda_{\pi \mathrm{C}}^2 \cdot \mathrm{u}_{\pi\rho S}. \tag{3.8}$$

The elementary charge e_π can be found in the form

$$e_\pi = \pm(\sqrt{\alpha_\pi}) \cdot (m_{\pi \mathrm{e}} \cdot \lambda_{\pi \mathrm{C}})^{1/2} \cdot c. \tag{3.9}$$

The Planck mass $m_{\pi \mathrm{P}}$, given (1.21), we find in the form

$$m_{\pi \mathrm{P}} = k_{\pi R}^{1/3} \cdot 4 \cdot \pi^2 \cdot \mathrm{f}_{\pi s}^2 \cdot u_{\pi l}^2 \cdot \mathrm{u}_{\pi\rho S}. \tag{3.10}$$

Find Planck's constant h_π in the form

$$h_\pi = m_{\pi \mathrm{e}} \cdot \lambda_{\pi \mathrm{C}} \cdot c. \tag{3.11}$$

Based on the known formula for the Planck mass

$$m_{\mathrm{P}} = \sqrt{\frac{h \ \cdot c}{G}} \tag{3.12}$$

and from the equality (3.10) and (3.12):

$$k_{\pi R}^{1/3} \cdot 4 \cdot \pi^2 \cdot \mathrm{f}_{\pi s}^2 \cdot u_{\pi l}^2 \cdot \mathrm{u}_{\pi\rho S} = \sqrt{\frac{h_\pi \cdot c}{G_\pi}}, \tag{3.13}$$

find from (3.13) gravitational constant Newton G_π in the form

$$G_\pi = \frac{h_\pi \cdot c}{k_{\pi R}^{2/3} \cdot 16 \cdot \pi^4 \cdot \mathrm{f}_{\pi s}^4 \cdot u_{\pi l}^4 \cdot \mathrm{u}_{\pi\rho S}^2}. \tag{3.14}$$

From the relation

$$m_{\pi \mathrm{P}} \cdot l_{\pi \mathrm{P}} = m_{\pi \mathrm{e}} \cdot \lambda_{\pi \mathrm{C}} \tag{3.15}$$

can find the length of the Planck $l_{\pi \mathrm{P}}$ in the form of

$$l_{\pi \mathrm{P}} = \frac{m_{\pi \mathrm{e}}}{m_{\pi \mathrm{P}}} \cdot \lambda_{\pi \mathrm{C}} \tag{3.16}$$

and the Planck time as

$$t_{\pi \mathrm{P}} = \frac{l_{\pi \mathrm{P}}}{c}. \tag{3.17}$$

To determine the lifetime of the neutron we write the equation (1.23) in the form

$$(\sqrt{2} \cdot \pi)^3 \cdot \pi^2 \cdot \mathrm{f}_{\pi s} = (1 + \vartriangle y_\pi \cdot \alpha_\pi)^3 \quad (\vartriangle y_\pi - \text{parametric offset machining}). \tag{3.18}$$

Parameter $\mathrm{f}_{\pi s}$ from (3.18):

$$\mathrm{f}_{\pi s} = \frac{(1 + \vartriangle y_\pi \cdot \alpha_\pi)^3}{(\sqrt{2} \cdot \pi)^3 \cdot \pi^2}. \tag{3.19}$$

The lifetime $\tau_{\pi nS}$ of short-lived neutrons $n_{\pi S}$ determine, taking into account (3.19), as

$$\tau_{\pi nS} = \frac{k_{\pi R}^{1/3}}{f_{\pi s}} \cdot u_{\pi t} = \frac{(\sqrt{2}\cdot\pi)^3 \cdot \pi^2 \cdot k_{\pi R}^{1/3}}{(1+\vartriangle y_\pi \cdot \alpha_\pi)^3} \cdot u_{\pi t}, \tag{3.20}$$

The lifetime $\tau_{\pi nL}$ of long-lived neutrons determine from (3.20), provided $\vartriangle y_\pi \cdot \alpha_\pi = 0$, in the form of

$$\tau_{\pi nL} = (\sqrt{2}\cdot\pi)^3 \cdot \pi^2 \cdot k_{\pi R}^{1/3} \cdot u_{\pi t}. \tag{3.21}$$

Note that, when presence of the neutron has two life times, the baryon asymmetry of the Universe finds its natural explanation.

The **Table** presents the results of theoretical calculations of fundamental constants (italics protoconstants).

Table

The name of the parameter	Symbol	The numerical value (SGS)
scalar parameter of structure of space-time	$f_{\pi s}$	$1.161\,712\,977\,019\,596\,928\,9703 \cdot 10^{-3}$
electromagnetic constant	α_π	$1.161\,409\,733\,400\,893\,939\,4882 \cdot 10^{-3}$
fine-structure constant	$\alpha_{\pi th}$	$7.297\,352\,572\,519\,857\,423\,5458 \cdot 10^{-3}$
Wavelength	λ_π	$2.258\,941\,438\,338\,421\,412\,6297 \cdot 10^{-10}$ sm
Rydberg constant	$R_{\pi\infty}$	$1.178\,679\,395\,222\,205\,270\,7871 \cdot 10^{5}$ sm^{-1}
the matching coefficient*	$k_{\pi R}$	1.074 091 696 0293
Compton wavelength	$\lambda_{\pi C}$	$2.426\,310\,240\,7358 \cdot 10^{-10}$ sm
electron mass	$m_{\pi e}$	$9.109\,382\,325\,3407 \cdot 10^{-28}$ g
elementary charge	e_π	$4.803\,204\,354\,1651 \cdot 10^{-10}$ g$^{-1/2}$ sm$^{3/2}$ s^{-1}
Planck constant	h_π	$6.626\,069\,154\,6019 \cdot 10^{-27}$ g sm^2 s^{-1}
Planck mass	$m_{\pi P}$	$5.456\,379\,113\,3014 \cdot 10^{-5}$ g
Planck length	$l_{\pi P}$	$4.050\,706\,001\,8742 \cdot 10^{-33}$ sm
Planck time	$t_{\pi P}$	$1.351\,170\,082\,4289 \cdot 10^{-43}$ s
Newtonian constant of gravitation	G_π	6.672 177 502 9339 g^{-1} sm^3 s^{-2}
lifetime neutron $n_{\pi S}$	$\tau_{\pi nS}$	881.552 698 044 s
lifetime neutron $n_{\pi L}$	$\tau_{\pi nL}$	886.423 939 853 s

* – value (CODATA 2010) from the NIST website: $R_\infty = 1.097\,373\,156\,8539(55)$ sm^{-1} (SGS), the speed of light in vacuum $c = 2.997\,924\,58 \cdot 10^{10}$ sm$\cdot$s^{-1} (SGS).

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