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Fine-Structure Constant Derived from the Structural Constant of All Atoms

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Abstract

The fine-structure constant α was introduced into physics by Arnold Somerfeld more than a century ago (1915). This quantity is attributed with the significance of describing the interaction between electrically charged particles and photons and its official value is α = 7.297 352 5643(11) × 10^{-3} [$1/\alpha$ = 137.035999177(21)] according to the National Institute of Standards and Technology, NIST, on October 18, 2025. This constant is the ratio of the square of the electron charge e to twice the product of the vacuum permittivity ε_0, Planck's constant h, and the speed of light in a vacuum c; $\alpha = e^2/(2\varepsilon_0 hc)$. So, fine-structure constant is expressed using four physical constants, which give the specified dimensionless physical number. The physical meaning of this constant has never been fully explained, so various meanings and properties are still attributed to this constant today. Since this constant appears in many physical phenomena, and without any real insight into its physical background, many people refer to it as a *mystical constant*. In article here, the fine-structure constant is physically derived using the *structural constant of all atoms*, which is in turn related to the ionization energy of each individual atom. This gives things a different and clear meaning, so there is no room for any mysticism now. Here we will provide a physically clear basis for interpreting the meaning of the fine-structure constant, this uses theoretical methods of the author of this article as well in experimental tests conducted by NIST, when testing the ionization potential of 110 atoms from Mendeleev's periodic table of elements, starting from hydrogen, with ordinal number one, to Darmstadtium, with ordinal number 110. In short, the research mentioned here has confirmed the existence of the *structural constant of all atoms* in each atom with an accuracy greater than any other NIST physical quantity, which means that these other physical quantities in which the *structural constant of all atoms* appears should be corrected accordingly, as stated for each specific case in this article.

Keywords

Fine-Structure Constant, Structural Constant of All Atoms, Ionization Potential of Single Atom, Mendeleev's Periodic Table, Unit of Substance Type "boscovich"

1. Introduction

Following Planck's dilemma of 28 October 1919 [1], whether the quantization of light is an intrinsic property of light itself or whether quantum action occurs within the atom, I have investigated here the latter possibility, *i.e.*, that quantum phenomena occur within the atom. In doing so, I assume that there is an electromagnetic oscillator in the atom that generates an electromagnetic wave from the atom, in fact a photon, using Maxwell's equations and the theory of relativity [2]. Investigation of the properties of such an oscillator in the atom leads to the realization of the discretization of the state in the atom and the necessity of the existence of a constant in the atom, which I first observed theoretically, and later confirmed this constant with NIST measurements and which constant I called the *structural constant of all atoms* and denoted it by s_0, [2]. This *structural constant* s_0 contains the number of the electrons in one orbit (z), the atomic number in Mendeleev's table (Z), the atomic orbital number ($n^{\pm 1}$), and the ratio of the ionization energy of the atom eV_{em} to the relativistic rest energy of the electron (mc^2). Although the result of connecting these quantities is ultimately a simple *structural constant* s_0, the relationships between the aforementioned quantities are mathematically complex, so it has not been simple or easy to determine the value of this constant until now. This article is based on this. Since the expression for s_0 contains the ordinal number Z of each atom from Mendeleev's table, I called this expression the *structural constant of all atoms* and denoted it by s_0. The justification for writing this article is provided by the good results obtained from the mathematical connection between the *structural constant* s_0 and the fine-structure constant α, where it is shown how the fine-structure constant α is derived in a simple way from the *structural constant* s_0. The key results of this work are that the *structural constant* s_0, which is theoretically based on four physical atomic quantities [z, Z, $n^{\pm 1}$, $eV_{\mathrm{em(n)}}$] and one constant (mc^2), can be determined by only one precise measurement, for which measurement the most accurate measurement of the ionization energy of the hydrogen atom to twelve decimal places is used [$eV_{\mathrm{em(n)}} =$ 13.598434599702 eV [3]], because it has been proven that the *structural constant* s_0 is independent of the ratio of the atomic number Z in Mendeleev's periodic table of elements and the ionization energy $eV_{\mathrm{em(n)}}$ of each individual atom, and that this constant $s_0 = 8.27869189307729$. From the theory presented here it follows that the maximum number of atoms in Mendeleev's periodic table of atoms is equal to $2s_0^2$, or 137.0734789210073. Since this is the largest possible number of atoms in Mendeleev's periodic table of elements, not counting isotopes, it logically follows that the mathematical distance between two neighboring atoms is actually equal to the fine-structure constant $\alpha = 1/\left(2s_0^2\right)$ = 7.2953572629 × 10^{-3}

= 1B = 1 boscovich [4]. This is a completely new definition of the fine-structure constant, but it will be shown here to be quite effective. This constant α here can be completely connected to the Somerfeld constant, but this requires that certain changes be taken into account in the Somerfeld constant, which will be discussed later, especially regarding the participation of Planck's constant h; if $\varepsilon_0\mu_0c^2 = 1$, $\alpha = e^2/(2\varepsilon_0hc) = (e^2\mu_0c)/(2h)$. As we will see later, Planck's constant is $h = \mu_0ce^2s_0^2$. This way $\alpha = 1/\left(2s_0^2\right)$. So, we reach almost the same result in two ways:

- Somerfeld: $\alpha = e^2/(2\varepsilon_0hc) = 7.2973525643(11) \times 10^{-3}$.
- 1B = 1 boscovich = $1/\left(2s_0^2\right)$ = 1/137.0734789210073 = $7.295357263 \times 10^{-3}$.

This means that the Somerfeld constant is 0.0273% higher than the fine-structure constant according to [4], which is also confirmed by the most precise measurements given in [5].

2. Methods

First, the method of theoretical research presented here and in [2] was used, where it was determined using Maxwell's equations and the theory of relativity that in the assumed oscillator inside the atom there is a discretization of the state during the movement of electrons in the orbits of these electrons, and then that the existence of one constant in atoms is necessary, which I called the *structural constant of all atoms* and denoted by s_0. Then, on 110 measurements of the ionization energy of atoms, I established the existence of this constant, which was a good confirmation of the mentioned theory. So, the article is based on my theoretical results and confirmed with experimental results from NIST.

Namely, from the theoretical consideration of the behavior of electrons in the atom, using Maxwell's electrodynamics and the theory of relativity [2], it emerged that there is one constant s_0 in the atom, which is always the same for all atoms, during ionization of the atom, until the last electron is ejected from the atom, which I called the *structural constant of all atoms* and marked it with s_0 - the text of this article describes the arrival of this constant in detail, where the justification for introducing the name of the *structural constant of all atoms* is stated. I would like to mention that all NIST measurements published so far on 110 atoms, from Hydrogen atoms to Darmstadium atoms, confirm the existence of the constant s_0.

2.1. Structural Constant of All Atoms

To explain the concept of the *structural constant of all atoms*, a fundamental approach to atoms is required, which includes Maxwell's equations and the theory of relativity.

First, we will explain the newly introduced concept of the *structural constant of all atoms*.

Let's go in order. Let us first examine the model under consideration here.

By solving the aforementioned Planck dilemma in such a way that the quantization of light occurs within matter, which has permeability μ_0 and permittivity ε_0, I mathematically placed the Lecher line in the physically small space of the atom. This may seem physically inappropriate, but let's keep in mind that solving

Planck's approach, for quantization to occur in matter, required exactly that. And I immediately note that it will prove fruitful, if we use Maxwell's equations and the theory of relativity.

a) A section of Lecher's line that is long ζ; it is a tween-lead transmission line consisting of pair of ideal conductive nonmagnetic wires of diameter 2ρ, separated by δ, situated in space with permittivity ε_0 and permeability μ_0, [2].

b) Lecher's line presented by an infinite number of extremely small uniformly distributed capacitors, with capacitance $C'\mathrm{d}\zeta$ and with equals such distributed inductors, with inductance $L'\mathrm{d}\zeta$, [6] (pp. 359, 60).

c) All mentioned capacitors are collected at the open end of the line, denoted by C, and all mentioned inductors are collected on its short-circuited end, and denoted by L, resulting in an LC circuit, placed inside an insulated sphere of radius r, the capacity of that sphere is $C = 4\pi\varepsilon_0 r$, [7] (pp. 565-8). Considering the properties of such a transmission line (ideal conductive nonmagnetic wires), I would like to point out that such a line can be mathematically processed independently of its possible physical implementation, which means that the transit line in the atom does not need to be realized but can be quite well described mathematically. The transmission line does not physically exist within the atom, but its mathematical model is used, just as mathematical models in space exploration work well without celestial bodies involved.

The net force acting on an electron in an atom is equal to the time derivative of the vector of momentum $\boldsymbol{p} = m\boldsymbol{v}$ [7] (p. 859);

$$\boldsymbol{F} = \frac{\mathrm{d}\boldsymbol{p}}{\mathrm{d}t} = \mathrm{d}\left(\frac{m\boldsymbol{v}}{\sqrt{1-\beta^2}}\right)\Big/\mathrm{d}t. \tag{1}$$

The Eq. (1) is also valid for the relativistic theory, the only thing to take into account is that then the mass m varies with the speed of motion, so Newton's second law $\boldsymbol{F} = m\boldsymbol{a}$ does not apply, m is the rest mass of the electron and $\boldsymbol{v}$ is the velocity vector of its motion.

In the stationary state, in circular motion of particle q around particle Q, when variables are at their fixed amounts, Coulomb's attractive force $\frac{qQ}{4\pi\varepsilon_0 r^2}$ [7] (p. 509) and centrifugal force are equalized; we take that q and Q have **opposite** sign and q is **negative**. This means that it is valid:

$$\frac{mv^2}{r\sqrt{1-\beta^2}} = -\frac{qQ}{4\pi\varepsilon_0 r^2}. \tag{2}$$

From Eq. (2) it follows:

$$r = -\frac{qQ}{4\pi\varepsilon_0 mc^2}\frac{\sqrt{1-\beta^2}}{\beta^2}. \tag{3}$$

The kinetic energy of the moving body (particle) is [7] (pp. 859-62)

$$K = \frac{mc^2}{\sqrt{1-\beta^2}} - mc^2. \tag{4}$$

To consider the presence of potential energy U in the relativistic case, let's look at relative-istic charged particle in electromagnetic field.

The relativistic Lagrangian for a particle with rest mass m and charge q is given by [8], according to the definitions in the electromagnetic field (derivatives of individual quantities are marked with a dot above the respective quantity):

$$\mathcal{L}(t) = -mc^2\sqrt{1-\frac{\dot{\boldsymbol{x}}(t)^2}{c^2}} + q\dot{\boldsymbol{x}}(t)\cdot\boldsymbol{A}(\boldsymbol{x}(t),t) - q\varphi(\boldsymbol{x}(t),t). \tag{5}$$

The particle's canonical momentum is:

$$\boldsymbol{p}(t) = \frac{\mathcal{L}}{\dot{\boldsymbol{x}}} = \frac{\dot{\boldsymbol{x}}(t)}{\sqrt{1-\frac{\dot{\boldsymbol{x}}(t)^2}{c^2}}} + q\boldsymbol{A}, \tag{6}$$

that is, the sum of the kinetic momentum and the potential momentum.

Solving Eq. (6) for the velocity, we get:

$$\dot{\boldsymbol{x}}(t) = \frac{\boldsymbol{p}-q\boldsymbol{A}}{\sqrt{m^2+\frac{(\boldsymbol{p}-q\boldsymbol{A})^2}{c^2}}}. \tag{7}$$

The Hamiltonian is:

$$\mathcal{H}(t) = \dot{\boldsymbol{x}}\cdot\boldsymbol{p} - \mathcal{L} = c\sqrt{m^2c^2+(\boldsymbol{p}-q\boldsymbol{A})^2} + q\varphi. \tag{8}$$

This results in the force equation (equivalent to the Euler-Lagrange equation)

$$\dot{\boldsymbol{p}} = -\frac{\mathcal{H}}{\boldsymbol{x}} = q\dot{\boldsymbol{x}}\cdot(\nabla\boldsymbol{A}) - q\nabla\varphi = q\nabla(\dot{\boldsymbol{x}}\cdot\boldsymbol{A}) - q\nabla\varphi\,, \tag{9}$$

from which one can derive

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{m\dot{\boldsymbol{x}}}{\sqrt{1-\frac{\dot{\boldsymbol{x}}}{c^2}}}\right) &= \frac{\mathrm{d}}{\mathrm{d}t}(\boldsymbol{p}-q\boldsymbol{A}) = \dot{\boldsymbol{p}} - q\frac{\boldsymbol{A}}{t} - q(\dot{\boldsymbol{x}}\cdot\nabla)\boldsymbol{A},\\ &= q\nabla(\dot{\boldsymbol{x}}\cdot\boldsymbol{A}) - q\nabla\varphi - q\frac{\boldsymbol{A}}{t} - q(\dot{\boldsymbol{x}}\cdot\nabla)\boldsymbol{A},\\ &= q\boldsymbol{E} + q\dot{\boldsymbol{x}}\times\boldsymbol{B}.\end{aligned} \tag{10}$$

The above derivation makes use of the vector calculus identity:

$$\frac{1}{2}\nabla(\boldsymbol{A}\cdot\boldsymbol{A}) = \boldsymbol{A}\cdot\boldsymbol{J}_A = \boldsymbol{A}\cdot(\nabla\boldsymbol{A}) = (\boldsymbol{A}\cdot\nabla)\boldsymbol{A} + \boldsymbol{A}\times(\nabla\boldsymbol{A}). \tag{11}$$

An equivalent expression for the Hamiltonian as function of the relativistic kinetic momentum, $\boldsymbol{P} = m\dot{\boldsymbol{x}}(t) = \boldsymbol{p} - q\boldsymbol{A}$ is:

$$\mathcal{H}(t) = \dot{x}\cdot\boldsymbol{P}(t) + \frac{mc^2}{\gamma} + q\varphi(\boldsymbol{x}(t),t) = \gamma mc^2 + q\varphi(\boldsymbol{x}(t),t) = E + U, \tag{12}$$

here

$$\gamma = \frac{1}{\sqrt{1-\frac{\dot{\boldsymbol{x}}^2}{c^2}}} = \frac{1}{\sqrt{1-\beta^2}}. \tag{13}$$

This has the advantage that kinetic momentum **P** can be measured experimentally whereas canonical momentum **p** cannot. Notice that the Hamiltonian (total energy) can be viewed as the sum of the relativistic energy (kinetic energy + rest energy), Eq. (12), plus the potential energy U:

$$E = K + mc^2 + U = \frac{mc^2}{\sqrt{1-\beta^2}} + U. \tag{14}$$

Taking into account that the potential φ determined from the Coulomb force $\frac{qQ}{4\pi\varepsilon_0 r^2}$ is equal to $\frac{Q}{4\pi\varepsilon_0 r}$, and taking into account equation (11), the potential energy U is:

$$U = q\varphi = -\frac{mc^2\beta^2}{\sqrt{1-\beta^2}}. \tag{15}$$

Let us now determine the potential φ from $\frac{Q}{4\pi\varepsilon_0 r}$ and from Eq. (3):

$$\varphi = \frac{Q}{4\pi\varepsilon_0 r} = -\frac{mc^2\beta^2}{q\sqrt{1-\beta^2}}. \tag{16}$$

Since electric potential is defined as potential energy per unit charge, then the potential energy of a charge q when moving between two points a and b is equal to:

$$\Delta U = qV_{\mathrm{b}} - qV_{\mathrm{a}} = q\varphi_{\mathrm{b}} - q\varphi_{\mathrm{a}} = U_{\mathrm{b}} - U_{\mathrm{a}} = qV_{\mathrm{ba}}. \tag{17}$$

In order for the system to remain stationary (*meaning it no longer emits or absorbs energy*) it has by law of conservation of energy emitted exactly such a large amount of energy $\Delta W = W - W_0 = E_{\mathrm{em}} = qV_{\mathrm{em}}$, with the opposite sign between ΔW and E_{em}; namely, the energy lost by the atom ΔW gets to the emitted energy E_{em} of the photon. For simplicity, we will take that initial velocity β_0 is always zero, so from the previous expression it follows:

$$E_{\mathrm{em}} = -W = -qV_{\mathrm{em}}, \tag{18}$$

which can be related to equations (4) and (15):

$$\begin{aligned} E_{\mathrm{em}} = K + U &= \left(\frac{mc^2}{\sqrt{1-\beta^2}} - mc^2\right) + \left(-\frac{mc^2\beta^2}{\sqrt{1-\beta^2}}\right) \\ &= -mc^2\frac{-1+\beta^2+\sqrt{1-\beta^2}}{\sqrt{1-\beta^2}} = -mc^2\left(1-\sqrt{1-\beta^2}\right) = -qV_{\mathrm{em}}, \end{aligned} \tag{19}$$

where $V_{\mathrm{em}} = V_{\mathrm{U}}$ is the potential difference (voltage) through which passes the body charged with charge q to get the same energy as the electromagnetic energy E_{em} emitted (as we have said, the charge q is negative; $q = -ze$, $z = 1,2,3,\cdots$, e is elementary charge, while $Q = +Ze$, $Z = 1,2,3,\cdots$ is positive).

From Eq. (19) we can express $\sqrt{1-\beta^2} = \left(1 - \frac{E_{\mathrm{em}}}{mc^2}\right)$ and $\beta^2 = 2E_{\mathrm{em}}\frac{\left(1-\frac{E_{\mathrm{em}}}{2mc^2}\right)}{mc^2}$, and we include these two in Eq. (3), we get:

$$r = -\frac{qQ}{4\pi\varepsilon_0 mc^2}\frac{\sqrt{1-\beta^2}}{\beta^2} = -\frac{qQ}{8\pi\varepsilon_0 E_{\text{em}}}\frac{\left(1-\frac{E_{\text{em}}}{mc^2}\right)}{\left(1-\frac{E_{\text{em}}}{2mc^2}\right)}, \tag{20}$$

and also:

$$U = q\frac{Q}{4\pi\varepsilon_0 r} = qV_{\text{U}} = -\frac{mc^2}{\sqrt{1-\beta^2}}\beta^2 = -\frac{2E_{\text{em}}\left(1-\frac{E_{\text{em}}}{2mc^2}\right)}{\left(1-\frac{E_{\text{em}}}{mc^2}\right)}. \tag{21}$$

$$E_{\text{em}} = -\frac{qQ}{8\pi\varepsilon_0 r}\frac{1-\frac{E_{\text{em}}}{mc^2}}{1-\frac{E_{\text{em}}}{2mc^2}}. \tag{22}$$

Furthermore, with Eq. (19), ($E_{\text{em}} = -qV_{\text{em}}$, and $\varepsilon_0 = \frac{1}{\mu_0 c^2}$) from Eq. (22) we get:

$$r = \left|\frac{\mu_0 c^2 Q}{8\pi V_{\text{em}}}\frac{1-\frac{qV_{\text{em}}}{mc^2}}{1-\frac{qV_{\text{em}}}{2mc^2}}\right|. \tag{23}$$

So, for example, for the simplest case, for the first orbit, with measured [3] V_{em} = 13.598434599702 V, ($q = -ze = -e$; $Q = Ze = e$), from Eq. (23) we calculate the radius of the first Hydrogen orbit, r_{H} = 5.294526279 × 10^{-11} m, and with V_{em} = 54.417765 V, ($q = -ze = -e$; $Q = Ze = 2e$), we get the radius of the first orbit of Helium, r_{He} = 2.645988600 × 10^{-11} m, and with V_{em} = 1362.19915 V, ($q = -ze = -e$; $Q = Ze = 10e$), we get the first orbit of Neon, r_{Ne} = 5.278386334 × 10^{-12} m, while for Darmstadtium, V_{em} = 204,400 V, ($q = -ze = -e$; $Q = Ze = 110e$), the first orbit is r_{Ds} = 2.905992468 × 10^{-13} m. For multi-electron atoms, it would be necessary to apply Hamilton's equations to point masses systems, which we will not go into here.

The electromagnetic energy E_{em} in the observed structure, which can be an atom too, is the energy of LC oscillator [7] (pp. 572, 696-701):

$$E_{\text{em}} = \frac{1}{2}\frac{\Theta^2}{C} = \frac{1}{2}LI^2 = \frac{1}{2}L\omega^2\Theta^2. \tag{24}$$

The charge Θ in Eq. (24) is the maximum charge on condenser whose capacitance is $4\pi\varepsilon_0 r$ [7] (pp. 565-8), The correlation between the frequency f and the angular frequency ω is Eq. (7), $\omega = 2\pi f = 1/\sqrt{LC}$

$$C = 4\pi\varepsilon_0 r, \tag{25}$$

and the inductance L, from Eq. (24), and with $\omega = 2\pi f$, is

$$L = \frac{1}{\omega^2 C} = \frac{1}{4\pi^2 f^2 C}. \tag{26}$$

When we equate Eq. (22) and Eq. (24) we get $\frac{1}{2}\frac{\Theta^2}{C}$:

$$-\frac{1}{2}\frac{qQ}{4\pi\varepsilon_0 r}\frac{\left(1-\frac{E_{\mathrm{em}}}{mc^2}\right)}{\left(1-\frac{E_{\mathrm{em}}}{2mc^2}\right)}=\frac{1}{2}\frac{\Theta^2}{C}. \tag{27}$$

Taking into account equation (24) from Eq. (27) we get:

$$\Theta^2=-qQ\frac{1-\frac{E_{\mathrm{em}}}{mc^2}}{1-\frac{E_{\mathrm{em}}}{2mc^2}}. \tag{28}$$

From expressions (25) and (26) we introduce the *characteristic impedance* of an *LC* circuit as [9], ($R = 0\ \Omega$, $G = 0$ S):

$$Z_{LC}=\sqrt{\frac{R+j\omega L}{G+j\omega C}}=\sqrt{\frac{L}{C}}=\sqrt{\frac{\frac{1}{\left(4\pi^2 f^2 C\right)}}{C}}=\sqrt{\frac{1}{4\pi^2 f^2 C^2}}=\frac{1}{2\pi fC}. \tag{29}$$

Now we will write Eq. (24) in a different way, by using $\omega=2\pi f=1/\sqrt{LC}$, Eq. (28) and Eq. (29) to show that the energy of the electromagnetic oscillator E_{em} is proportional to its *natural* (or resonant) *frequency of LC* circuit: $f=1/\left(2\pi\sqrt{LC}\right)$:

$$\begin{aligned}E_{\mathrm{em}}&=\frac{1}{2}\frac{\Theta^2}{C}=\frac{1}{2}\frac{\pi}{\pi}\frac{\Theta^2}{\sqrt{C}\sqrt{C}}\frac{\sqrt{L}}{\sqrt{L}}=\pi\sqrt{\frac{L}{C}}\Theta^2\frac{1}{2\pi\sqrt{LC}}\\&=\pi Z_{LC}\Theta^2 f=\pi\sqrt{\frac{L}{C}}\left(-qQ\frac{1-\frac{E_{\mathrm{em}}}{mc^2}}{1-\frac{E_{\mathrm{em}}}{2mc^2}}\right)f=Af.\end{aligned} \tag{30}$$

It is important to note that although the charge Θ^2, from Eq. (28), participates in Eq. (30) for the energy E_{em}, that charge does not participate in the expression for the frequency $f=1/\left(2\pi\sqrt{LC}\right)$. Therefore, the electromagnetic energy E_{em}, according to Eq. (30), consists of two separate components, one component is dependent on the variables Θ^2, in accordance with equation (28), and the other component is dependent on the fixed parameters of the oscillatory *LC* circuit, $f=1/\left(2\pi\sqrt{LC}\right)$. This will later play an important role in determining of the *structural constant* s_0.

In Eq. (30) the factor *A* is the *action of the electromagnetic LC oscillator*; it is quotient of electromagnetic energy E_{em} to the natural frequency *f* of *LC* oscillator, it is by definition Planck's *h*:

$$A=\frac{E_{\mathrm{em}}}{f}=-\pi\sqrt{\frac{L}{C}}qQ\frac{1-\frac{E_{\mathrm{em}}}{mc^2}}{1-\frac{E_{\mathrm{em}}}{2mc^2}}. \tag{31}$$

The action of the electromagnetic oscillator *A* is the *proportionality factor* of the electromagnetic energy E_{em} and the natural frequency *f* of *LC* circuit. This proportionality factor may or may not necessarily be a constant. All of this depends on the relationships between the electromagnetic energy E_{em} and the natural frequency *f*, which we will see later.

Capacitance per unit length C' of Lecher line [6] (p. 61), is:

$$C' = \frac{\pi\varepsilon_0}{\ln\left(\frac{\chi}{2+\sqrt{\left(\frac{\chi}{2}\right)^2-1}}\right)}, \tag{32}$$

and inductance per unit length L' of Lecher line is [6] (p. 360), is:

$$L' = \frac{\mu_0\left(\ln\chi+\frac{1}{4}\right)}{\pi}. \tag{33}$$

So, the *characteristic impedance of Lecher line*, according to Eq. (29), Eq. (32) and Eq. (33), is:

$$\begin{aligned} Z_{\mathrm{LC}} &= \frac{1}{2\pi fC} = \sqrt{\frac{L}{C}} = \sqrt{\frac{L'd\zeta}{C'd\zeta}} = \sqrt{\frac{L'}{C'}} \\ &= \sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{\sqrt{\left[\ln\left(\frac{\chi}{2}+\sqrt{\left(\frac{\chi}{2}\right)^2-1}\right)\right]\left(\ln\chi+\frac{1}{4}\right)}}{\pi} = \sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{\sigma(\chi)}{\pi}, \end{aligned} \tag{34}$$

while

$$\sigma(\chi) = \sqrt{\left[\ln\left(\frac{\chi}{2}+\sqrt{\left(\frac{\chi}{2}\right)^2-1}\right)\right]\left(\ln\chi+\frac{1}{4}\right)} \tag{35}$$

we call the *structural coefficient the Lecher line.*

If we now express the frequency *f* from equations (35), (39), (44) and (45) we get:

$$f = \frac{1}{2\pi Z_{LC}C} = \frac{1}{2\pi\sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{\sigma(\chi)}{\pi}C} = \frac{1}{2\pi\sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{\sigma(\chi)}{\pi}4\pi\varepsilon_0 r} = \frac{1}{8\pi\sqrt{\varepsilon_0\mu_0}\sigma(\chi)r}. \tag{36}$$

If we now introduce *r* from equation (30) into equation (36), we get:

$$f = \frac{1}{\sqrt{\varepsilon_0\mu_0}\sigma(\chi)\frac{qQ}{\varepsilon_0 E_{\mathrm{em}}}\frac{1-\frac{E_{\mathrm{em}}}{mc^2}}{1-\frac{E_{\mathrm{em}}}{2mc^2}}} = \frac{E_{\mathrm{em}}}{\sqrt{\frac{\mu_0}{\varepsilon_0}}\sigma(\chi)zZe^2}\frac{1-\frac{E_{\mathrm{em}}}{2mc^2}}{1-\frac{E_{\mathrm{em}}}{mc^2}}. \tag{37}$$

We will determine the direct expression for the photon frequency *f* (or its wavelength $\lambda = c/f$) based on the theoretical assumptions made so far later.

2.2. More about the Structural Constant of All Atoms

The characteristics of an *LC* oscillator are an inherent property of the oscillator itself and depend only on the structural parameters of the *LC* circuit under consideration, and do not depend on variables in that *LC* circuit, such as charges, currents or voltages in that *LC* circuit. The natural frequency given by equation

(37) is also an inherent property of the LC oscillator and does not depend on the charge qQ appearing in that equation. In order to avoid this dependence of the natural frequency f on the charge product qQ in the LC cir-cuit, in Eq. (37), the product $\sigma(\chi)qQ=-\sigma(\chi)zZe^2$ should be Constant 1, actually since e^2 is constant in itself, so it should be $-\sigma(\chi)zZ$ a Constant 2 = s_0^2, with, as stated above, $q=z(-e)=-ze$ and $Q=Z(+e)=Ze$, where elementary charge e is used only as measure of the charge, but not as a variable; it should be kept in mind that at the beginning we said that the charge q would be considered negative, *i.e.*, $q=-ze$, so $\sqrt{-1}=\mathrm{i}$, and

$$s_0=\left|\sqrt{\sigma(\chi)zZ}\right|=\text{Constant 3}, \tag{38}$$

the factors z and Z theoretically do not necessarily have to be an integer. The larger z or Z, the proportionally smaller $\sigma(\chi)$, so that s_0 is kept constant. The emitted (or absorbed) electromagnetic energy E_{em} depends on the variable charge Θ^2. However, as noted after equation (30), this does not affect the frequency f. Therefore, the energy E_{em} does not have to satisfy the stated requirement that the frequency does not depend on the variables and can remain as such in Eq (37).

Since the constant s_0 in equation (38) now appears as such for the first time, and is related to all atoms through the occurrence of the ordinal number Z in that constant, I propose that it be called the ***structural constant of all atoms*** (note here that it is not the ***fine-structure constant*** α (we will show later that there is a strong connection between them, but they are two different physical constants).

If we now return to Eq. (31), using Eq. (37) and Eq. (38), and take $\sqrt{\frac{\mu_0}{\varepsilon_0}}=\mu_0 c$, we get:

$$A=\frac{E_{\mathrm{em}}}{f}=\frac{E_{\mathrm{em}}}{\dfrac{E_{\mathrm{em}}}{\sqrt{\dfrac{\mu_0}{\varepsilon_0}}\sigma(\chi)zZe^2}\dfrac{1-\dfrac{E_{\mathrm{em}}}{2mc^2}}{1-\dfrac{E_{\mathrm{em}}}{mc^2}}}=\frac{1}{\dfrac{1}{\mu_0 ce^2 s_0^2}\dfrac{1-\dfrac{E_{\mathrm{em}}}{2mc^2}}{1-\dfrac{E_{\mathrm{em}}}{mc^2}}}$$
$$=\mu_0 ce^2 s_0^2\frac{1-\dfrac{E_{\mathrm{em}}}{mc^2}}{1-\dfrac{E_{\mathrm{em}}}{2mc^2}}=A_0\frac{1-\dfrac{E_{\mathrm{em}}}{mc^2}}{1-\dfrac{E_{\mathrm{em}}}{2mc^2}}. \tag{39}$$

Here A_0 is the part of action of LC oscillator that does not depend on the speed of the electron motion, and this part is:

$$A_0=\mu_0 ce^2 s_0^2. \tag{40}$$

According to Eq. (39) it is valid:

$$E_{\mathrm{em}}=A_0 f\frac{1-\dfrac{E_{\mathrm{em}}}{mc^2}}{1-\dfrac{E_{\mathrm{em}}}{2mc^2}}, \tag{41}$$

$$E_{\mathrm{em}}=Af, \tag{42}$$

and from Eq. (39) is possible two solutions, after solving this equation with E_{em} as a variable:

$$E_{\text{em1}} = A_0 f + mc^2 - \sqrt{\left(A_0 f\right)^2 + \left(mc^2\right)^2}\,, \tag{43a}$$

$$E_{\text{em2}} = A_0 f + mc^2 + \sqrt{\left(A_0 f\right)^2 + \left(mc^2\right)^2} \tag{43b}$$

and since Eq. (42) and Eq. (43a), (43b)

$$A = A_0 + \frac{mc^2}{f} \mp \sqrt{A_0^2 + \left(\frac{mc^2}{f}\right)^2}\,. \tag{44}$$

This theoretically derived Planck's *h*. Namely, by definition, *h* is the ratio between the energy of a photon and its frequency, from Eq. (42); $A = h = E_{\text{em}}/f$, and whether that will be a constant or not, we will only see later after the measurements. In any case, in the theory presented here, the ratio of radiated energy and its frequency are not predicted in advance as either variable or constant, but are completely independent, and only their calculation or their measurements show what the real relationship between them is.

To check accuracy of Eq. (43a), (43b) and Eq. (44), it is necessary to determine the amount of the energy E_{em}, or ionization voltage V_{em}, the amount of the frequency *f*, and the amount of the structural constant s_0. All other quantities needed for the aforementioned verification of Eq. (43a), (43b) and Eq. (44) are already known (μ_0, c, e, m). Starting from equation Eq. (19) and Eq. (31) we get Duane-Hunt law [8] [9] [10], with *relativistic correction* (originally $f = eV_{\text{em}}/h$, here *h* is Planck's constant), and *f* reads:

$$\begin{aligned} f &= \frac{eV_{\text{em}}}{A_0}\,\frac{1-\dfrac{eV_{\text{em}}}{2mc^2}}{1-\dfrac{eV_{\text{em}}}{mc^2}} = \frac{eV_{\text{em}}}{\mu_0 c e^2 s_0^2}\,\frac{1-\dfrac{eV_{\text{em}}}{2mc^2}}{1-\dfrac{eV_{\text{em}}}{mc^2}} = \frac{mc^2}{\mu_0 c e^2 s_0^2}\,\frac{\left(\dfrac{1}{2}\beta^2\right)}{\sqrt{1-\beta^2}} \\ &= \frac{mc^2}{2\mu_0 c e^2 s_0^2}\,\frac{\beta^2}{\sqrt{1-\beta^2}} = \frac{mc}{2\mu_0 e^2 s_0^2}\,\frac{\beta^2}{\sqrt{1-\beta^2}} = f_0\,\frac{\beta^2}{\sqrt{1-\beta^2}}. \end{aligned} \tag{45}$$

Here $f_0 = \dfrac{mc}{2\mu_0 e^2 s_0^2}$ is the *natural frequency of the electron*, which belongs to the electron regardless of its speed of motion. It is also possible to calculate the natural frequencies for all other particles; *i.e.*, for protons, neutrons, hyperons, ... depending on their masses. An interesting expression is obtained if we multiply this expression for the natural frequency f_0, with the expression A_0, Eq. (40), we get: $A_0 f_0 = \mu_0 c e^2 s_0^2 \dfrac{mc}{2\mu_0 e^2 s_0^2} \mu_0 c e^2 s_0^2 = \dfrac{1}{2} mc^2$, we get the classic expression for the kinetic energy of an electron that would move at the speed of light. The physical interpretation of this expression is not clear and we will not go into it now. This is only an indication of a mathematical possibility but is not a physical explanation of the above expression Eq. (44) and Eq (45).

2.3. Quantization of the States in the Atom

In the atom there are at least two independent physical phenomena that enable the existence of the atom itself. One is the uniform circular motion of the electron around the nucleus with a speed v at a distance r, and the other is the oscillation of the electromagnetic energy generated within the atom. The time T_ϕ of one complete revolution of the electron around the nucleus (the so-called *period*) is:

$$T_\phi = \frac{2r\pi}{v}, \tag{46}$$

and from that

$$\phi = \frac{1}{T_\phi} = \frac{v}{2r\pi}, \tag{47}$$

ϕ is the *frequency of the rotation* of body charged with the charge q. Entirely different oscillation period, is period of *electromagnetic oscillation*, T_{em}, with frequency f:

$$T_{\text{em}} = \frac{1}{f}, \tag{48}$$

and

$$f = \frac{1}{T_{\text{em}}}. \tag{49}$$

Using Eq. (45), ($f = \frac{mc^2}{\mu_0 ce^2 s_0^2}\frac{\left(\frac{1}{2}\beta^2\right)}{\sqrt{1-\beta^2}}$), and Eq. (47), ($\phi = \frac{1}{T_\phi} = \frac{v}{\frac{-2qQ}{4\pi\varepsilon_0 mc^2}\frac{\sqrt{1-\beta^2}}{\beta^2}\pi}$), let's make a frequency ratio $\frac{f}{\phi}$:

$$\frac{f}{\phi} = \frac{\frac{mc^2}{\mu_0 ce^2 s_0^2}\frac{\left(\frac{1}{2}\beta^2\right)}{\sqrt{1-\beta^2}}}{\frac{v}{\frac{-2qQ}{4\pi\varepsilon_0 mc^2}\frac{\sqrt{1-\beta^2}}{\beta^2}\pi}} = -\frac{qQc}{4ve^2 s_0^2}. \tag{50}$$

Electromagnetic energy in the atom can exist as a standing wave. The standing wave does not transmit the energy, but it sways existing energy. If the natural frequency of the LC oscillator is f, as the *active power* then standing wave oscillates with dual frequency $2f$ [11] (p.437-8),

$$f_{\text{Sw}} = 2f. \tag{51}$$

Thesis: *In order for the electromagnetic standing wave to exist in the atom, there must be a mutual synchronization relationship between* the frequency of electron motion around the nucleus ϕ and the frequency f of oscillation of electromagnetic energy in the atom f (it should be noted here that other integer relations between these two phenomena are theoretically possible):

$$\phi = nf \,, \tag{52}$$

where n is one of the whole numbers 1, 2, 3, …. Both above mentioned phenomena in respect of synchronization are equal; so also applies

$$f = n\phi \,. \tag{53}$$

The two Eqs. (52, 53), can be written as one expression

$$f = n^{\pm 1}\phi \,, \tag{54}$$

or, because of Eq. (51) and Eq. (54):

$$f = \frac{1}{2} f_{\text{Sw}} = \frac{1}{2} n^{\pm 1}\phi \,, \tag{55}$$

From equation (50) we obtain the equation for the particle velocity in the n-th state v_{n}:

$$v_{\text{n}} = -\frac{qQc}{4\left(\dfrac{f}{\phi}\right) e^2 s_0^2} \,, \tag{56}$$

and due to equation (55) we get:

$$v_{\text{n}} = -\frac{qQc}{4\left(\dfrac{1}{2} n^{\pm 1}\right) e^2 s_0^2} = -\frac{c}{2n^{\pm 1} s_0^2} \frac{qQ}{e^2} = -\frac{c}{2n^{\pm 1} s_0^2} \frac{(-ze)(+Ze)}{e^2} = \frac{czZ}{2n^{\pm 1} s_0^2} \tag{57}$$

According to Eq. (55), the frequency of the electromagnetic wave in the n-the state f_{n} is:

$$f_{\text{n}} = \frac{1}{2} n^{\pm 1}\phi_n \,, \tag{58}$$

From Eq. (57), taking into account $v_{\text{n}} = c\beta_{\text{n}}$, we obtain:

$$\beta_{\text{n}} = \frac{zZ}{2n^{\pm 1} s_0^2} \,. \tag{59}$$

Now we can express β_{n} from equation (29)

$$\beta_{\text{n}} = \sqrt{-\frac{2qV_{\text{em}}}{mc^2}\left(1 + \frac{qV_{\text{em}}}{2mc^2}\right)} = \sqrt{-\frac{qV_{\text{em}}}{mc^2}\left(2 + \frac{qV_{\text{em}}}{mc^2}\right)} \tag{60}$$

and equate it with β_{n} from equation (59). We get:

$$\sqrt{-\frac{qV_{\text{em}}}{mc^2}\left(2 + \frac{qV_{\text{em}}}{mc^2}\right)} = \frac{zZ}{2n^{\pm 1} s_0^2} \,. \tag{61}$$

From Eq. (61) we get ***structural constant of all atoms*** s_0 determined by the new method, which proves to be the most accurate:

$$s_0 = \frac{\sqrt{zZ}}{\sqrt{2n^{\pm 1}\sqrt{1 - \left(1 - \dfrac{eV_{\text{em(n)}}}{mc^2}\right)^2}}} \,. \tag{62}$$

Let us now recall the meaning of all the quantities in equation (62):

z is the number of electrons in one orbital of the atom, Z is the atomic number in Mendeleev's periodic table, $n^{\pm 1}$ is the ordinal number of an orbital (shell) in an atom. This expression, in addition to the usual paths $n = n^{+1} = 1, 2, 3, 4,\ldots$, also predicts paths $n = n^{-1} = 1, 2, 3, 4,\ldots$ [2], which opens up the possibility of electron paths in the atom below the first orbit, so for example a neutron can be considered a hydrogen atom with path $n = n^{-1} = 126$, whereby the mass of the electron in neutron due to its speed and relativistic effects increases so much that the neutron becomes 0.14% heavier than the proton, [2], m is the rest mass of one electron, c is the speed of light in vacuum, e is the charge of one electron and $V_{\mathrm{em(n)}}$ is the ionization potential of a single atom.

The fine-structure constant α by Somerfeld is expressed with four physical constants (e, ε_0, h, c). Here the *structural constant* s_0 is expressed in Eq. (62) with four physical quantities [z, Z, $n^{\pm 1}$, $eV_{\mathrm{em(n)}}$] and one physical constant, (mc^2). It was shown in [2] that the investigation of the *structural constant* s_0 can be done with two physical quantities, Z and $eV_{\mathrm{em(n)}}$, and one physical constant, mc^2; therefore, we calculate that in Eq. (62) is $z = 1$ and $n^{\pm 1} = 1$.

When the problem is simplified in this way, we come to a new discovery: The ratio of two quantities, Z and $eV_{\mathrm{em(n)}}/\left(mc^2\right)$ is a constant [2]. In this way, s_0 in Eq. (62) is always constant, independent of Z and relationship of $eV_{\mathrm{em(n)}}/\left(mc^2\right)$. This allows us to use just one measurement to determine the value of s_0, that is, any measurement. Of course, in this sense, we will use the measurement that is most accurate, which is the measurement of the ionization potential of hydrogen, H. If I may say so, it seems to me that the discovery of the constancy of the ratio of the number Z to $eV_{\mathrm{em(n)}}/\left(mc^2\right)$ is my most significant contribution to this research, which revealed the *structural constant of all atoms* s_0, [2].

From Eq. (62) we obtain 2 (two) solutions for the atomic ionization voltage $V_{\mathrm{em(n)}}$:

$$V_{\mathrm{em\,1\,(n)}} = \frac{mc^2}{ze}\left(1-\sqrt{1-\left(\frac{1}{n^{\pm 1}}\frac{zZ}{2s_0^2}\right)^2}\right), \tag{63}$$

and

$$V_{\mathrm{em\,2\,(n)}} = \frac{mc^2}{ze}\left(1+\sqrt{1-\left(\frac{1}{n^{\pm 1}}\frac{zZ}{2s_0^2}\right)^2}\right). \tag{64}$$

$V_{\mathrm{em\,1\,(n)}}$ in Eq. (63) is the ionization potential with the amount starting from the lowest ion-ization potential for the first ordinal number of atoms in the Mendeleev's periodic table, *i.e.*, for hydrogen, H, up to the ionization potential for the last ordinal number of atoms in the Mendeleev's periodic table, $V_{\mathrm{em\,1\,(n)}} = mc^2/e = 510\,998.9462$ V, *i.e.*, for the atom with an unknown name XX that has not yet been discovered.

$V_{\mathrm{em\,2\,(n)}}$ in Eq. (64) is the ionization potential with a value starting from the highest ionization potential [$V_{\mathrm{em\,2\,(n)}} = 2mc^2/e = 1\,021\,997.892$ V] for the something similar like hyperons Ξ^0 or Λ^0, through the neutron n^0, which in this theory is understood as the hydrogen atom with the number $n^{\pm 1} = n^{-1} = 126$,

$V_{\text{em 2 (n) n}^0} = 712207.8053\ \text{V}$, [2], and all the way to the ionization potential for the last atomic number in Mendeleev's table, that is, for the atom with the unknown name XX, which has not yet been discovered.

The common point of the ionization voltages $V_{\text{em 1 (n)}}$ and $V_{\text{em 2 (n)}}$ is the point at which these two voltages are equal, Eq. (63) equal to Eq. (64), and this point will serve us to determine the value of $Z_{\max}$:

$$\frac{mc^2}{ze}\left(1-\sqrt{1-\left(\frac{1}{n^{\pm1}}\frac{zZ_{\max}}{2s_0^2}\right)^2}\right)=\frac{mc^2}{ze}\left(1+\sqrt{1-\left(\frac{1}{n^{\pm1}}\frac{zZ_{\max}}{2s_0^2}\right)^2}\right). \tag{65}$$

$$2\sqrt{1-\left(\frac{1}{n^{\pm1}}\frac{zZ_{\max}}{2s_0^2}\right)^2}=0. \tag{66}$$

Squaring of Eq. (66) and arranging gives the expression:

$$4\left(1-\frac{1}{n^{\pm12}}\frac{z^2Z_{\max}^2}{4s_0^4}\right)=0. \tag{67}$$

From equation (67) it finally follows:

$$Z_{\max}=\frac{2s_0^2n^{\pm1}}{z}. \tag{68}$$

To simplify things, and this will not affect the calculation of s_0, we will assume that $n^{\pm1} = 1$ and $z = 1$, then:

$$Z_{\max}=2s_0^2. \tag{69}$$

The electron velocity v_n in of the cited article [2] is

$$v_n=\frac{czZ}{2n^{\pm1}s_0^2}. \tag{70}$$

If we divide Eq. (70) by the speed of light in vacuum c, we get:

$$\beta_n=\frac{v_n}{c}=\frac{zZ}{2n^{\pm1}s_0^2}. \tag{71}$$

If an electron approaches the nucleus close enough that its speed becomes equal to the speed of light ($\beta_n=\frac{v_n}{c}=\frac{zZ}{2n^{\pm1}s_0^2}=1$), then at the same time Z is equal to $Z_{\max}$.

Since the derivative of Eq. (62) with respect to Z, after inserting Eq. (63), is equal to zero, which means that s_0 is independent of Z, *i.e.*, that s_0 is constant, then it is sufficient to take only one exact measurement result and calculate with it as a constant all the time (s_0 = constant). If we proceed in this way and use the NIST hydrogen ionization voltage (energy), 13.598434599702 eV, as the most accurate measurement result (on October 16, 2025.), we get:

$$s_0=8.27869189307729. \tag{72}$$

From there, according to equation (69) it follows:

$$Z_{\max}=2s_0^2=137.0734789210073. \tag{73}$$

Table 1. Seven (7) initial constants (s_0, B, c, μ_0, e, m, m_p) convert (9) nine constants in interchangeable.

Quantity	Symbol	Formula	Value	Unit	Difference[a]
Structural constant of all atoms	s_0	s_0	8.27869189307729[b]	1	0.0000
Unit of substance type = boscovich	B	$1/2s_0^2$	$7.295357264 \times 10^{-3}$	1	0.0000
Max. number of diff. type of atoms	1/B	$2s_0^2$	137.0734721	1	0.0000
Speed of light in vacuum	c	c	299,792,458	m s^{-1}	0.0000
Vacuum magnetic permeability	μ_0	μ_0	$1.256637061 \times 10^{-6}$	N A^{-2}	0.0000
Elementary charge	e	e	$1.602176634 \times 10^{-19}$	C	0.0000
Electron mass	m	m	$9.1093837139 \times 10^{-31}$	kg	0.0000
Proton mass	m_p	m_p	$1.6726219259 \times 10^{-27}$	kg	0.0000
Down: 9 *interchangeable constants*					
1. Fine-structure constant: $e^2/(2\varepsilon_0 hc)$	α	$e^2/(2\varepsilon_0 hc)$	$7.2953572629 \times 10^{-3}$	1	−0.0273[c]
1. a) Inverse-fine structure constant	α^{-1}	$2\varepsilon_0 hc/e^2$	$1.37073478921 \times 10^{2}$	1	+0.0273[c]
2. von Klitzing constant	R_K	$\mu_0 c s_0^2$	$2.58198673316 \times 10^{4}$	Ω	+0.0273[c]
3. Planck constant	h	$\mu_0 c e^2 s_0^2$	$6.6278822905 \times 10^{-34}$	J Hz^{-1}	+0.0273[c]
3. a) Conversion constant, K_0	K_0	$1/\left(2\mu_0 c e s_0^2\right)$	$1.2086640579 \times 10^{14}$	Hz V^{-1}	unknown
4. Ratio $e/h = 2K_0$	e/h	$1/\left(\mu_0 c e s_0^2\right)$	$2.4173281159 \times 10^{14}$	Hz V^{-1}	−0.0273[c]
5. Josephson constant $= 4K_0$	K_J	$2/\left(\mu_0 c e s_0^2\right)$	$4.8346562319 \times 10^{14}$	Hz V^{-1}	−0.0273[c]
6. Rydberg constant	R_∞	$m/\left(8\mu_0 e^2 s_0^6\right)$	$1.09647324437 \times 10^{7}$	m^{-1}	−0.0819[c]
7. Bohr radius	a_0	$\mu_0 e^2 s_0^4/(\pi m)$	$5.2946671331 \times 10^{-11}$	m	+0.0546[c]
8. Bohr magneton	μ_B	$\mu_0 c e^3 s_0^2/(4\pi m)$	$9.2765464621 \times 10^{-24}$	J T^{-1}	+0.0273[c]
9. Nuclear magneton	μ_N	$\mu_0 c e^3 s_0^2/\left(4\pi m_p\right)$	$5.0521650185 \times 10^{-27}$	J T^{-1}	+0.0273[c]

[a] It is the difference with "2022 CODATA recommended values" in percent. https://physics.nist.gov/constants; [b] *This calculation is based on the values provided by NIST, Eq.* (62), $eV_{em(n)} = 13.598434599702$ eV, https://www.nist.gov/pml/atomic-spectra-database, s_0 has not yet been included in the physical quantities at NIST, and its inclusion will require an appropriate correction of all those physical quantities in which s_0 appears; [c] This difference disappears completely if Planck's constant instead of $h = 6.626\,070\,040 \times 10^{-34}$ J Hz^{-1} is equal to $A_0 = \mu_0 c e^2 s_0^2 = 6.6278822905 \times 10^{-34}$ J Hz^{-1}, *i.e.*, when it is increased by +0.0273%, with the note that A_0 here is a theoretically calculated value and confirmed by 110 NIST ionization voltage measurements [2]. All discrepancies would disappear if the current value of Planck's h were increased by +0.0273%, as suggested by the expression $A_0 = \mu_0 c e^2 s_0^2 = 6.6278822905 \times 10^{-34}$ J Hz^{-1} [2].

On Monday, October 13, 2025, at one of our working meetings, Mr. Filip Vučić proved by dimensional analysis that the dimensionless Eq. (72) and (73) cannot be obtained in any other way by including any physical quantities, so we will continue to treat them as precisely determined original physical constants.

One way of using the *structural constant of all atoms* s_0 is visible from **Table 1**.

2.4. Fine-Structure Constant

According to Eq. (73), the largest possible atomic number in Mendeleev's periodic table is equal to 137.0734789210073. In [2] it was explained that it does not necessarily have to be a whole number, because reaching $Z_{\max}$ is related to the speed of electron movement and not to charge discretization. This means that the largest number of different types of atoms (not counting isotopes) in Mendeleev's table is 137.0734789210073. In other words, the numerical value of the distance between two different types of atoms, therefore, the fine-structure constant or unit of measurement for the type of substance "boscovich" is, [4]:

$$\begin{aligned}\alpha &= \frac{1}{Z_{\max}} = \frac{1}{2s_0^2} = \frac{1}{137.0734789210073} = 0.0072953572629194 \\ &= 7.2953572629194 \times 10^{-3}.\end{aligned} \tag{74}$$

In this way, the aim of this article is fully fulfilled, without any physical ambiguities; the arrival to the *structural constant of all atoms* s_0 is explained and then, in connection with the *structural constant* s_0, the arrival at the fine-structure constant α is shown. If we compare the value of fine-structure constant α calculated here with the value written in the Abstract and recommended by NIST, then we notice that the value of α calculated here is 0.0273% lower than the currently valid official value of the fine-structure constant. Since this differ-ence of 0.0273%, compared to the NIST data, is obtained from NIST's most precise meas-urements of the ionization potential of the hydrogen atom with 12 decimal places, and purely mathematically forwarded it follows that the accuracy is as much as two orders of magnitude higher compared to other NIST physical quantities, which means that these other physical quantities should be corrected by ±0.0273% or a whole multiple of that, depending on the physical quantity in question (see **Table 1**).

When we know s_0, we can also calculate the frequency f_{n} of the discrete system [2]:

$$f_{\mathrm{n}} = \frac{mcz^2Z^2}{8e^2\mu_0\left(n^{\pm1}\right)^2 s_0^6\sqrt{1-\left(\frac{1}{n^{\pm1}}\frac{zZ}{2s_0^2}\right)^2}}. \tag{75}$$

Now, for discrete states of atoms, the energies, electron velocities, and photon frequencies in those states are determined.

3. Conclusion

The theoretically derived expression for the atomic *structural constant* s_0 *of all atoms* has been discussed in detail. By explaining the meaning of individual quantities in the *structural constant* s_0 *of all atoms*, it has been established that this *structural constant* also includes those states in atoms that are below the first orbital of the atom, which means, for example, that a neutron can be considered a hydrogen atom in which an electron rotates in the orbit $n = n^{\pm1} = n^{-1} = 126$, where the mass of that electron, due to its high velocity of motion and relativistic action, contributes to an increase in the neutron mass by +0.14% compared to the proton mass [2]. It has been mathematically proven that s_0 is a constant that is independent of atomic number in Mendeleev's periodic table of elements. Using the most accurately measured NIST ionization potential of the hydrogen atom to 12 decimal places, the *structural constant* s_0 has been calculated, $s_0 = 8.27869189307729$. This achieves a measurement accuracy greater than that of all other NIST physical quantities. This in turn requires that all other physical quantities containing s_0 be appropriately corrected for the required (+ or –) 0.0273% or an integer multiple of 0.0273%. After the atomic *structural constant* s_0 has been precisely determined in this way, it is mathematically easy to determine that the maximum possible number of atoms in Mendeleev's table $Z_{\max}$ is equal to $2s_0^2$ which is 137.0734789210073. In other words, Mendeleev's periodic table of elements can contain a maximum of 137.0734789210073 different types of atoms. Therefore, if there can be a maximum of 137.0734789210073 different types of atoms in Mendeleev's table, then the smallest mathematical distance between these atoms is equal to $1/Z_{\max} = 0.0072953572629194 = 7.29535726292 \times 10^{-3}$, which is 0.0273% less than the fine-structure constant α given in the Abstract. Thus, the fine-structure constant α is introduced here in a different way than usual. In addition to the use of the *structural constant* s_0 shown in **Table 1**, the use of the fine-structure constant α is now extended similarly to the other physical quantities mentioned there, given the aforementioned immediate mathematically derived connection between these two constants. A new explanation of the meaning of the fine-structure constant α enables simultaneously a number of new interpretations of the phenomena associated with this change. Certainly, those interpretations that interpreted the fine-structure constant α as an inexplicable and mysterious phenomenon should no longer exist, because now the physical connection between atom ionization and the *structural constant* s_0, and then the fine-structure constant α, has been clearly proven. If the required corrections according to **Table 1** are taken into account, and compared with the most accurate measurements given in the attached literature [5], it is shown that the fine-structure constant completely coincides with the Somerfeld constant from the introduction of this paper.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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