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Fine-structure constant, alpha (α)

*Disclosure of the mystery
of the number α*

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Part 1

1. Introduction

A very important **law** of **Nature**, which **determines** the **course** of **wave processes**, was **discovered** by us in the framework of the **Wave Model**.

In the **previous video** [1], I already **mentioned this** briefly.

Namely, it **was found** that the **value** of the **ratio** of the **transverse** wave λ_t of **superstructure** to the **longitudinal** wave λ of the **basis**,

$$\frac{\lambda_t}{\lambda} = \frac{2\pi a}{\lambda} = \frac{a}{\tilde{\lambda}} = \frac{v}{c} \quad (1)$$

characterizes the strict **scale correlation** that exists between **two characteristic parameters** of the **wave process** related, respectively, to the **superstructure** and the **basis** of the **wave**.

As for the **ratio** of **speeds** in (1), then v is the **oscillation speed** of the **superstructure** of the wave process. The **speed** " c " is the **basis** (phase) **speed** of **propagation** of the **wave process**.

The **basis speed vector coincides** with the **wave vector** $k = 2\pi / \lambda$. The **oscillation speed vector** is **perpendicular** to the wave vector.

In the **case** when c is the **basis speed** of the **atomic** and **subatomic** levels (equal to the speed of light), and the **oscillation speed** is equal to the **speed** of the **electron** in the **first Bohr orbit** in the **hydrogen atom**, $v = v_0$, we arrive at the **following relation**, denoted by the letter **alpha**,

$$\alpha = \frac{v_0}{c} \quad (2)$$

Arnold Sommerfeld first **drew attention** to the **magnitude** of this **ratio** of two characteristic speeds, $\alpha \approx 1/137$.

The **fact** is that **the same number** $\alpha \approx 1/137$, as **Sommerfeld discovered**, is **obtained** from the following **combination** of **three fundamental constants-parameters** known by then in physics (e , \hbar and c):

$$\alpha = \frac{e^2}{\hbar c} \quad (\text{CGSE}) \quad (3)$$

Since then, the **dimensionless number** α , presented in the **form** (3), has been **considered** in physics as a **separate fundamental physical constant**, defined as the “**fine-structure constant** α (alpha)”, since the **parameters-constants** making up α are **included** in the **formulas** that determine the structure of **optical spectra**.

However, the **deep meaning** of the **constant** α (**what determines** the **value** of **relation** (3)?) was **not understood** by **Sommerfeld** and, unfortunately, has not been understood by **physicists** to date, **remaining** the **greatest mystery**.

So, the **knowledge** of the **nature** of the **alpha number** (3), which was **defined** as a **fine-structure constant** α , from the very beginning as it has been and continues to be **one of the most complex** and **unsolved problems** of **theoretical physics**.

Here is one of **Richard P. Feynman's comments** on this subject.

"There is a most profound and beautiful question associated with the observed coupling constant, ... It has been a mystery ever since it was discovered more than fifty years ago, ... Immediately you would like to know where this number for a coupling comes from: is it related to pi or perhaps to the base of natural logarithms? Nobody knows. It's one of the greatest damn mysteries of physics: a magic number that comes to us with no understanding by man. You might say the "hand of God" wrote that number, and "we don't know how He pushed his pencil."

[QED: *The Strange Theory of Light and Matter*,
Princeton University Press. (1985) p. 129]

Max Bourn stated the following.

“It is clear that the explanation of this number must be the central problem of natural philosophy”

[A.I. Miller (2009), *Deciphering the Cosmic Number: The Strange Friendship of Wolfgang Pauli and Carl Jung*, W.W. Norton & Co, p. 253]

For Pauli, the **theoretical origin** of the fine structure constant **was also**

“... the most important of the unsolved problems of ... physics.”

«When I die, the first thing I shall consider asking devil is – what is the meaning of the Fine Structure Constant?».

And so on.

The **mystery** of the **number** α was **revealed** only **recently** in the framework of the **new basic physical theory** based on **dialectics**, the **Wave Model** (WM), which **we developed** to **replace** the theories of the **Standard Model** that currently **dominates physics**.

As we have **found out**, the **root cause** of **all problems** of physics, **including** the **problem** of the **physical meaning** of the **fine-structure constant** α , is connected with a **lack** of **understanding** (and therefore **not taking into account**) the **fact** that

**all objects, phenomena and processes in the Universe
have a wave nature.**

In particular, wave processes **determine** the **origin** of **elementary particles**, including **electrons**, and **determine** their **behaviour** ...

In the framework of one of the two theories of WM, the **Dynamic Model** of **elementary particles** (DM) [2, 3], the **problem** of α -**constant** was **solved** naturally [4].

Mainly this happened because the **nature** of the **origin** of the **mass** of **particles** as well as the **nature** of **their charges** were **disclosed** and **understood due to DM**. Thanks to this, the **true value** and **dimensionality** of the **electric charge** of the **electron** has **become known**.

Moreover, the **original meaning** and, accordingly, the **initial expression** for the **constant** \hbar **included** in **relation** for α (3) were also **taken into account**.

However, the above and other **discoveries** of the **Dynamic Model** remain **unknown** to a wide range of physicists.

As a consequence, **in result** of the **existing gap** in the **knowledge** of the **true nature** of the **components included** in **expression** (3), the **physical meaning** of the value of their combination, α -**constant**, naturally **remains misunderstood** and **continues** to be an **incomprehensible mystery** of physics.

Our studies have **concluded** that the **constant** α **reflects** the **fundamental regularity of wave motion**:

scale correlation of threshold states
of conjugated parameters
inherent in oscillation-wave processes.

We will **analyze** the **problem** and **show** how we **came** to this **conclusion**, that is, to the **disclosure** of the **physical meaning** of constant **alpha**.

This PowerPoint **presentation** is based on the **materials** of **two author's lectures** on the **Wave Model** [5, 6].

2. Definition of α -constant in physics

In **modern physics**, by the **fine-structure constant** α is called a **dimensionless quantity formed** (in SI system) from a **combination** of **four fundamental physical constants**: e , \hbar , c and ϵ_0 ,

$$\alpha = \frac{e^2}{4\pi\epsilon_0\hbar c} = 7.297352533 \times 10^{-3} \quad (4)$$

where $e = 1.602176462 \times 10^{-19} \text{ C}$ - **electron charge** (in coulombs);

$\hbar = 1.054571596 \times 10^{-34} \text{ J} \times \text{s}$ - **Planck constant** h **divided** by 2π ;

$\epsilon_0 = 8.854187817 \dots \times 10^{-12} \text{ F} \times \text{m}^{-1}$ - the so-called "**dielectric constant of free space**" (or "**electric constant**") [7, 8];

$c = 2.99792458 \times 10^8 \text{ m} \times \text{s}^{-1}$ - **speed of light**.

It is **generally accepted** to consider α as a **convenient measure** of the **strength** of **electromagnetic interaction**.

Accordingly, α is **considered** as a "**coupling constant**", which determines **how electrically charged elementary particles** (for example, an **electron**, a **muon**) and **light** (photons) **interact** with **each other**.

The **inverse value** of α is

$$\alpha^{-1} = 137.035999074 \quad (5)$$

The **constant** α was **first introduced** by **Arnold Sommerfeld** (in 1916) [9] when studying the **Balmer spectral series** in the framework of **Bohr's theory** (before the introduction of wave mechanics), as **quantity** $\alpha = v_0 / c$ (2), where v_0 is the **electron speed** in the **first Bohr orbit** in the H-atom, $v_0 = 2.187691251 \times 10^8 \text{ cm} \times \text{s}^{-1}$.

Then, **after** some **simple transformations** (in the CGSE system), Sommerfeld **discovered** that the **value** of the **ratio** of **speeds** α (2) is **equal** to the **value** of the **combination** (3) of the **three physical constants**, $v_0 / c = e^2 / \hbar c$.

Thus, thanks to Sommerfeld, a “**constant**” α appeared in physics **in the form** of the following **equalities**:

$$\alpha = \frac{v_0}{c}, \quad \alpha = \frac{e^2}{\hbar c} \quad (\text{CGSE}) \quad \text{and} \quad \alpha = \left(\frac{1}{4\pi\epsilon_0} \right) \frac{e^2}{\hbar c} \quad (\text{SI}) \quad (6)$$

Ignoring the **original relation** (2) (the first equality on the left in (6)), Sommerfeld **drew attention only** to the **expression** (3) (the second equality in (6)), **since** the **fundamental constants** (e , \hbar and c) that **make up** the **expression** for α (3) are **included** in the **formulas** that **determine** the **amount** of **splitting** in the **fine structure** of **spectral lines**.

Therefore, the **ratio** α (3) was called the **fine-structure constant**.

The **fine-structure constant** α is also **included** in the so-called “**relativistic correction**” for the spectral terms formula (obtained earlier by Sommerfeld), when the hydrogen atom is calculated using the **Dirac relativistic wave mechanics**.

3. The nature of the constituents in the expression for α

It **follows** from **equalities** (6) that the **numerical value** of α is obtained by **two combinations** of parameters. The **first one**, represented by the **ratio** of **speeds**, $\alpha = v_0 / c$, **did not arouse much interest** and was practically not discussed.

The **second expression** for the number α , **obtained** by **combining** the **fundamental constants-parameters** included in the **formulas** of the **optical spectra**, made it possible to **attribute** to the **numerical value** α the **meaning** of the “**coupling constant**”.

**But the attributed meaning
did not reveal the nature of the origin of a strictly defined quantity α .**

The **relation** $\alpha = e^2 / \hbar c$ **only shows** that α is a **combination** of fundamental **physical constants**: e , \hbar , and c .

In **theoretical physics**, these constants **characterize**, respectively:

the discrete nature of electric **charges** (e),
quantum theory (\hbar) and **relativity** theory (c).

The **reduced Planck constant** $\hbar = h / 2\pi$ (also called the **Dirac constant**) included in the expression for α (3), although it is considered in physics as **fundamental, is not** an **independent fundamental** constant.

Having appeared for the first time in the theory of the Bohr atom, \hbar is a **combination of three** truly fundamental **independent** parameters-constants - the **electron mass** m_e , the **Bohr speed** v_0 and the **Bohr radius** r_0 : $\hbar = m_e v_0 r_0$.

But the nature of the electron mass m_e is unknown.

In general, the **nature** of the **mass**, inherent in all forms of matter, is still **not understood**, is the **greatest mystery** for modern physics.

Based on the **Dynamic Model** of elementary particles (DM), proposed for the first time more than two decades ago [2, 10],

**we found out the nature of the origin of the mass of particles,
the nature of the electric charge, and, consequently, we now know**

**the nature of the electron mass m_e ,
the true value and dimensionality of its charge e ,
and also what the “electric constant” ε_0 actually represents.**

These **discoveries** have become the **main key** to solving the problem of **revealing** the **physical meaning** of the **fine-structure constant**.

The **next** such **key** was the **WM concept** that we adhere to, according to which **wave processes** have **collective character** [1].

The **expression** for the **electron charge** following from the formulas for α (6) (in units of the SI system) has the form:

$$e = \sqrt{4\pi\epsilon_0\hbar v_0} \quad (7)$$

The “**fundamental**” constant $\hbar = h/2\pi$ (**generated** by the **Bohr theory** of the atom), which is included in (7) and in the above formulas, is essentially the **orbital angular momentum**, P_{orb} , of an **electron** in the first Bohr orbit (of radius r_0); is defined, as already mentioned above, by the following equality:

$$\hbar = P_{orb} = m_e v_0 r_0 \quad (8)$$

where $m_e = 9.10938291 \times 10^{-28} \text{ g}$, $r_0 = 0.52917721092 \times 10^{-8} \text{ cm}$

The **Planck constant** $h = 2\pi\hbar$ is a physical quantity equal to the **orbital action** of the **electron** in the first Bohr orbit in the hydrogen atom, i.e., equal to the **orbital angular momentum** of the electron, P_{orb} , **multiplied** by 2π :

$$h = 2\pi P_{orb} = 2\pi m_e v_0 r_0 \quad (9)$$

Substituting the expression for \hbar (8) into equality (7), **we arrive** at the **formula for the electron charge**, expressed in terms of the **electron mass** m_e and two **characteristic parameters**, v_0 и r_0 , of the equilibrium orbital motion of the electron around the proton in the hydrogen atom:

$$e = \sqrt{4\pi\epsilon_0 m_e v_0^2 r_0} \quad (10)$$

The **dimensionality** of the **electron charge** following from (10), expressed by the **absolute units** of matter, space and time (g, cm, sec), is

$$[e] = g^{1/2} \times cm^{3/2} \times s^{-1} \quad (11)$$

The same **meaningless dimensionality** of the electric charge q follows from the **Coulomb law** $F = k \frac{q_1 q_2}{r^2}$ (both in the CGSE and in SI), where k is the **proportionality coefficient**, the **true value** and **dimensionality** of which are still **unknown** to physics (**like** the nature of the charge q), and therefore the **Coulomb law** is still **represented** in physics in its original **unfinished form** **as**:

$$F_{CGSE} = \frac{q_1 q_2}{r^2}, \quad F_{SI} = \left(\frac{1}{4\pi\epsilon_0} \right) \frac{q_1 q_2}{r^2} \quad (12)$$

Both expressions in (12) are presented for the so-called “**vacuum**”, where the **dielectric permeability** of the medium $\epsilon = 1$. In the **CGSE system** and in the **SI system**, the proportionality coefficient k is **equal** to **one**, because, **as** we have convincingly **shown**, in particular, in [8, 11],

$$\epsilon_0 = 8.854187817... \times 10^{-12} \text{ F} \times m^{-1} = \frac{1}{4\pi}, \quad \text{hence,} \quad \left(\frac{1}{4\pi\epsilon_0} \right) = 1$$

Thus, the **dimensionality** of the **electron charge** $[e]$ (11) is expressed if even in **absolute units** of matter (g), space (cm) and time (sec), but with **meaningless fractional exponents** for two absolute units.

This circumstance **led**, as a result, to the **appearance** in physics of **pseudo-dimensions** of **units** of **electric current** and **electric charge**, respectively, of **ampere** $[A]$ and **coulomb** $[C]$, which **covered** the **meaningless dimensionality** of **charge** mentioned above with **fractional exponents**, and the dimensionality of its derivative - **electric current**.

**The dimensionality in coulombs
does not say anything about the nature of the charge and
made its cognition even more problematic.**

So both expressions:

equality for α (4) and **Coulomb's law** (12), due to **ignorance** of the **true dimensionality** of the **electron charge** e , and also **due to** the **introduction** of a **meaningless "electric constant"** ε_0 , are **not understood** in essence of the content.

The **origin** of the number α is **unknown** ("*... where this number for a coupling comes from...*", Feynman), which is still considered **mystical** ("*... the most important of the unsolved problems of ... physics*", Pauli), and the **nature** of the **electric charge** is also **unknown**.

What is an electric charge?

To solve the **problem** of the **nature** of the **electric charge** q , it is necessary to **solve** the **problem** of the **proportionality coefficient** k between the **resulting force** F and the **functional dependence** q_1q_2/r^2 in the **Coulomb law** (12).

Namely, it is necessary to **determine** the **dimensionality** and **value** of the coefficient k (still **unknown** to modern physics).

This was what we did [8].

**Thanks to DM, the dimensionality and, therefore,
the physical meaning of electric charges were disclosed [3].**

It turned out that the **charge** has an **exchange character** and is a **measure** of the **rate of mass exchange** or, briefly, the power of mass exchange. The **dimensionality** of the **exchange charge** is $g \cdot s^{-1}$.

The exchange charge of an electron is

$$e = 1.702691627 \times 10^{-9} \text{ g} \times \text{s}^{-1}$$

According to DM, the electron charge is

the minimum quantum of the rate of mass exchange

This **discovery** made it possible to **understand** many things, in particular, to **reveal** the **true form** of the **Coulomb law**, as well as the **physical meaning** of the **alpha number** (4), defined in physics as a **fine-structure constant**.

4. Physical meaning of the alpha constant

In the **Dynamic Model** of elementary particles (DM) [2, 3], the speed v is the **oscillatory speed** of the boundary wave shells of particles, and c is the **basis wave** (phase) **speed** of their wave exchange (**interaction**) at the **subatomic** and **atomic** levels.

In accordance with DM, the **ratio** of the **oscillatory** and **wave components** of the speeds, v and c , respectively, of the **superstructure** and the **basis** of the wave process, **reflects** the existing **natural relationship** between **active** and **reactive** exchange **charges**, q_a и q (notions of the DM), associated with these speeds:

$$\frac{q_a}{q} = ka = \frac{\omega a}{c} = \frac{v}{c} \quad (13)$$

The **maximum oscillatory** speed v_{max} that a **lighter particle** of **superstructure** can have with respect to the **basis speed** c of its exchange **interaction** (bond) with the conjugated **heavier particle** in equilibrium is determined by the relation:

$$\alpha = \frac{v_{max}}{c} = \frac{v_0}{c} = 7.29735308 \cdot 10^{-3} = \frac{1}{137,035991} \quad (14)$$

where v_0 and c are the speeds **mentioned** above, respectively: the **speed** of the **electron** in the **first Bohr orbit** in the hydrogen atom (superstructure speed) and the **basis speed** of the **wave exchange** (interaction) of the **proton** with the **electron** and the **surrounding field-space**, equal to the speed of light.

In the general case, relation (14) expresses a **scale correlation** of the **basis** and **superstructure** of **wave fields-spaces**, i.e., **conjugate oscillatory-wave** processes in the Universe at all its levels.

To further **confirm** the **validity** of this **statement**, let us consider **as** the following **example** (after the hydrogen atom) the **parameters** of the **wave process** at the level of the **acoustic field** perceived by man.

5. Acoustic parameters defined by the constants α and h

One of the **dynamic parameters** of a person is the **threshold** of **audibility**.

The latter is equal to the **sound pressure** $P_{\min} = 2 \times 10^{-4} \text{ dyne} \times \text{cm}^{-2}$ at a **frequency** near $\nu = 1122 \text{ Hz}$ in air under **normal conditions** (temperature and pressure).

The **acoustic action** h_a and the **acoustic pressure** P are related by the following equality,

$$h_a = \frac{mP}{\rho \nu} \quad (15)$$

where m is the **average mass** of air **molecules** and ρ is the **density** of **air**.

Therefore, the **minimum acoustic action** $h_{a,min}$ at the threshold of human hearing, **corresponding** to the **minimum sound pressure** P_{min} , is

$$h_{a,min} = \frac{m_r u P_{min}}{\rho v} = 6.629 \times 10^{-27} \text{ erg} \times s \quad (16)$$

where $m_r = 28.96$ — average **relative mass** of air molecules,

$u = 1.66053873 \times 10^{-24} \text{ g}$ — **atomic mass unit** (*amu*),

$\rho = 1.293 \times 10^{-3} \text{ g} \cdot \text{cm}^{-3}$ — **air density**.

We see that the **action** of $h_{a,min}$ (16), associated with the **acoustic process**, practically **coincides with** the action of Planck (**Planck's constant**) related to **electromagnetic** processes:

$$h = 6.6260693 \times 10^{-27} \text{ erg} \times s$$

It cannot be random. Nature demonstrates perfect **harmony** both **within one** and between its **different levels**.

The **human body** contains $\approx 9.5\%$ of **hydrogen atoms**; therefore, certain **parameters** of a **person** at the **atomic level** must also **correlate** with whatever of the **basic parameters** of the **hydrogen atom**.

As shown above, this parameter turned out to be the **orbital angular momentum** of the **electron** in the **first Bohr orbit** — the **Planck constant** h .

It **should** also be **noted** that at the level of the **hearing threshold**, the **minimum threshold amplitude** of **acoustic vibrations** a_{min} at a frequency of 1781,25 Hz is

$$a_{min} = \frac{P_{min}}{2\pi\rho v_a v} = 4.1696 \times 10^{-10} \text{ cm} \quad (17)$$

where $v_a = 3.3146 \times 10^4 \text{ cm} \times s^{-1}$ - **speed** of **sound** in air (**basis speed** of an **acoustic wave**) under normal conditions.

The **obtained value** of a_{min} **coincides** with the theoretical **radius** of the **electron sphere** r_e (**electron radius**),

$$r_e \approx (m_e / 4\pi\varepsilon_0)^{1/3} = 4.169586917 \times 10^{-10} \text{ cm} \quad (18)$$

following from the formula

$$m = \frac{4\pi r^3 \varepsilon_0 \varepsilon_r}{1 + k^2 r^2} \quad (19)$$

of the **Dynamic Model** for the **mass** of elementary particles, where $\varepsilon_0 = 1 \text{ g} \cdot \text{cm}^{-3}$ is the absolute **unit** of **density**, at $k^2 r^2 \ll 1$ and $\varepsilon_r = 1$.

At the **upper acoustic threshold** of **pain** at **sound pressure** $P_{max} = 10^4 \text{ dyne} \times \text{cm}^{-2}$, the **oscillatory speed threshold** is

$$v_{osc,max} = \frac{P_{max}}{\rho v_a} = 2.418 \times 10^2 \text{ cm} \times s^{-1} \quad (20)$$

The **ratio** of the obtained **threshold** value of **oscillatory speed** $v_{osc,max}$ (**superstructure** of an **acoustic wave**) to the **basis wave speed** in air (sound speed), $c = v_a$, is

$$\alpha = \frac{v_{osc,max}}{v_a} = \frac{1}{137.08023} \quad (21)$$

The **obtained value** (21), related to the **wave process** at the **acoustic level**, practically **coincides** with the value (14),

$$\alpha = \frac{v_{max}}{c} = \frac{v_0}{c} = 7.29735308 \cdot 10^{-3} = \frac{1}{137,035991}$$

obtained from the relation **characterizing** the wave process occurring at the level of the **electromagnetic** field.

At the **electromagnetic field** level, the “**threshold**” oscillation **speed** (**superstructure** speed) is equal to the first **Bohr speed** v_0 , and the **wave speed** (basis speed) is equal to the speed of light c .

In the above sense, the **Bohr speed** v_0 , the speed of an electron in the first stationary orbit of radius r_0 (closest to the proton wave sphere) is the **limiting (threshold) orbital** speed of the electron that is **allowed** in the **proton-electron** system in a hydrogen atom.

6. The wave nature of the alpha constant

The **found regularity** expressed by the **ratios** of the **characteristic speeds** of the **basis** and the **superstructure** in two **wave processes** related to **two different** levels, **electromagnetic** (14) and **acoustic** (21), **indicates** that

**the ratio of the speeds is universal,
inherent in wave processes.**

Thus, all the above **arguments** show that the so-called "**fine-structure constant**" of the microworld α , **adopted** in modern physics as a **convenient measure** of the **strength** of **electromagnetic interaction**, actually reflects

scale correlation of threshold states
conjugated oscillatory-wave processes at different levels of the Universe,

including atomic and subatomic. **In other words**, α reflects

scale correlation of basis and superstructure parameters
wave fields-spaces of the Universe having a contradictory
spherical-cylindrical nature,

as this, for **example**, takes place in the **field-space** of a **hydrogen atom**.

The **hydrogen atom** is a **dynamically** coupled **centrally symmetric** system. The **central**, key (by mass) **component** - the **proton** - has a **spherical** wave field.

By this **spherical** (**radial**) field the **proton** binds (**exchanges**) with the **surrounding field-space** and with the **orbital electron**, the movement of which around the proton is **associated** with a **cylindrical** wave field.

The **behaviour** of both dynamic components of the **proton-electron system**, the **proton** and the **electron**, is **described**, respectively, by **spherical** and **cylindrical wave functions** [10], which are naturally and **harmoniously interconnected** in the system.

Thus, the **constant** α **reflects** the mentioned **harmonic relationship** of the **numerical values** of the **parameters** not only between the **two components** of the **proton-electron** system under consideration, but also **between** the **parameters** of **other** wave **conjugate systems**.

This **follows** from all the **data** obtained in **WM**.

Summarizing, there is **every reason** to **assert** that the **characteristic feature** we have examined, **reflecting** the **fundamental regularity in Nature**, makes up the **physical meaning** of the **alpha constant** (its **numerical** value).

The **ratio** $\alpha=v_o/c$, first obtained by A. Sommerfeld, as well as $\alpha=e^2/\hbar c$, **demonstrate** such a **regularity, harmonic relationship**, which exists, in particular, in the **hydrogen atom**.

Relatively **little time has passed** since the **first publications** on WM.

Therefore, of course, the **information** about the discovery within WM of the **physical meaning** of α , as a **scale factor** reflecting the **harmonic relationship** between the **oscillatory** and **wave components** of the wave process (quite **convincingly**, I believe, **shown here**), has **not yet reached** the **vast majority** of physicists who still adhere to the Standard Model.

Accordingly, the so-called “**coupling constant**” or “**fine-structure constant**” α (**introduced** into a series of truly **fundamental** physical **constants**) will remain yet long in physics as a **mystical dimensionless number** and considered as a convenient “**measure of the strength of electromagnetic interaction**”.

Part 2

7. Derivation of α -constant

To fully understand the physical meaning of the number α , to confirm its wave nature, let us derive various versions of the formulas for α .

We will based on the concepts and formalism of the Wave Model.

First we **derive** the α -**constant** formula in the **traditional** form, **accepted** in **physics** (**expression** (4)), in the **SI system**:

$$\alpha = \left(\frac{1}{4\pi\epsilon_0} \right) \frac{e^2}{\hbar c}$$

This expression contains the **fundamental constants**: e , \hbar и c , where e is the **electron charge** presented in **subjective** units, **coulombs**,

$$e = 1.602176462 \times 10^{-19} \text{ C} \quad (\text{SI})$$

But in **WM** we use the **electron charge** e in **objective units**, i.e., its **true value** and **dimensionality** (discovered in WM) in **absolute units** of **matter-space-time**:

$$e = 1.702691627 \times 10^{-9} \text{ g} \times \text{s}^{-1} \quad (\text{WM}) \quad (22)$$

As regards the **parameter** ϵ_0 in the **proportionality factor** $1/4\pi\epsilon_0$ (we considered it in detail in [8, 11]), it is **worth recalling** the following.

The “**constant**” ϵ_0 appeared in physics as a **result** of **manipulations** with **dimensionalities** when **creating** the **SI system**. It was **subjectively introduced** into a series of **fundamental constants** of physics as an “**electric constant**”.

This was a **gross mistake**.

Referring to what was said above in Part 1. Our studies have shown that

$$\varepsilon_0 = 8.854187817... \times 10^{-12} \text{ F} \times \text{m}^{-1} = \frac{1}{4\pi}, \quad \text{hence} \quad \frac{1}{4\pi\varepsilon_0} = 1, \quad (23)$$

and therefore, in fact, in the SI system of units, as in CGSE,

$$\alpha = \frac{e^2}{\hbar c} \quad (\text{CGSE and SI}) \quad (24)$$

We will use the energy relations considered in the previous video [1], where the fundamental features of the concepts adopted in the new basic physical theory, the Wave Model (WM) [10], for the description of wave motion-rest processes in physical fields-spaces, were discussed in some detail.

Suppose that quasiparticles of a certain microlevel, which are elementary masses-volumes, regularly move (oscillate) with an average speed v according to the exponential law,

$$\hat{v} = v(kr)e^{i\omega t} \quad (25)$$

If this oscillatory motion is superimposed on a wave motion whose velocity is equal to c , the total energy of the quasiparticle is presented in the following form:

$$E = \frac{m(c + \hat{v})^2}{2} = \frac{mc^2}{2} + mc\hat{v} + \frac{m\hat{v}^2}{2} \quad (26)$$

The component,

$$E_{cv} = mc\hat{v} \quad (27)$$

takes into account the **transfer** of **additional energy** caused by the **ordered movement** of the quasiparticle (this is the **oscillation-wave** energy of **wave mass exchange**). This energy can also be obtained as follows.

The **equation** for the **mass exchange** process at the **basis level** with a basis speed c has the form:

$$F = \frac{dm}{dt}c \quad (28)$$

Therefore, the **oscillation-wave** energy of **wave mass exchange** is

$$\hat{E}_{cv} = \int F d\hat{\Psi} = \int \frac{d\hat{\Psi}}{dt} c dm = c\hat{v} \int dm = mc\hat{v} \quad (29)$$

where $\hat{\Psi}$ - **displacement** at a **speed** \hat{v} .

The corresponding **mass transfer energy density** is

$$\hat{w}_{cv} = \varepsilon_0 \varepsilon c \hat{v} \quad (30)$$

The **wave flow** of **motion** with the resulting **energy density** (30) is **physiologically perceived** as “**pressure**”, and therefore it is called **pressure**.

At the level of **solids**, the kinematic-dynamic **energy density** (30) is called **stress**.

The **first term** in (26) is the **kinematic energy** of the **basis** level,

$$E = \int m \frac{dc}{dt} dl = \frac{mc^2}{2} \quad (31)$$

The **carrier energy** of mass exchange at a **basis level**, where $\frac{\langle dl \rangle}{dt} = c$, we call the **dynamic energy** of a particle at this level;

$$E_c = \int F \langle dl \rangle = \int c \frac{dm}{dt} \langle dl \rangle = c^2 \int dm = mc^2 \quad (32)$$

We came to a **formula** that coincides **in form** with the well-known in physics formula of the "**relativistic**" energy of particles. **This fact** and the **conclusions** following from it **were examined** in detail by us in [13].

The **density** of **dynamic energy** at a **basis** level is

$$w_c = \varepsilon_0 \varepsilon c^2 \quad (33)$$

The **third term** in (26) is the **oscillation energy**,

$$E = \frac{m\hat{v}^2}{2} \quad (34)$$

Mass exchange energy at the **level of oscillations**, where $F = \frac{dm}{dt} \hat{v}$ and $\hat{v} = \frac{d\hat{\Psi}}{dt}$, is

$$E_v = \int F \langle d\hat{\Psi} \rangle = \int \frac{dm}{dt} \hat{v} \langle d\hat{\Psi} \rangle = \hat{v}^2 \int dm = m\hat{v}^2 \quad (35)$$

The **density** of **dynamic energy** at the level of **oscillations** (superstructure) is equal to

$$\hat{w}_v = \varepsilon_0 \varepsilon \hat{v}^2 \quad (36)$$

At the level of **solids**, the **energy density** (36) is called the **elastic modulus**.

The mass exchange **energy densities** at the level of the **basis-superstructure** \hat{w}_{cv} (30) and the **basis level** \hat{w}_c (33) are related by the equality

$$\hat{w}_{cv} = \frac{\hat{v}}{c} \hat{w}_c \quad (37)$$

The **ratio** of **densities**, \hat{w}_v (36) to \hat{w}_{cv} (30), leads to a **similar relation**,

$$\hat{w}_v = \frac{\hat{v}}{c} \hat{w}_{cv} \quad (38)$$

The maximum value of the ratio \hat{v}/c at which solids are destroyed, called ultimate stress, is approximately equal to the value of α ,

$$\frac{\hat{v}}{c} \approx \frac{1}{137} \quad (39)$$

It should be **keep in mind** that at the **level** of **solids**, the **basis speed** c is equal to the **speed** of **sound** in them, $c = v_{sound}$.

We turn again to the expression $E_v = m v^2$ (35)

for the **case** when the **oscillatory** speed of the quasiparticle v is equal to the **oscillatory speed** v_0 of the **electron** in the **first Bohr orbit** of radius r_0 , and its **mass** m is, respectively, the mass of the electron m_e : $E_v = m_e v_0^2$.

The **electron mass** m_e is determined in the **Dynamic Model** (DM) [2, 3] according to the following simplified **formula**,

$$m_e = 4\pi\varepsilon_0 r_e^3 \quad (40)$$

where $\varepsilon_0 = 1 \text{ g} \times \text{cm}^{-3}$ is the **absolute unit** of **density**.

Substituting the **value** of **electron mass** m_e , known from the reference data, into formula (40) we find the **radius** of the **spherical shell** of the **electron** (electron radius) r_e ,

$$r_e = 4.17052597 \times 10^{-10} \text{ cm} \quad (41)$$

The **electron charge** is defined (following DM) by the expression,

$$e = m_e \omega_e \quad (42)$$

where ω_e – **fundamental frequency** of atomic and subatomic levels

$$\omega_e = 1.869162505 \times 10^{18} \text{ s}^{-1} \quad (43)$$

Taking the above equalities (**discovered in** DM) into account, as well as the **condition** of circular motion (for a **cylindrical field**) [10], that is, **Kepler's third law**,

$$v^2 r = \text{const} \quad (44)$$

from which it **follows** that $v_e^2 r_e = v_0^2 r_0$,

we come to the expression for the energy of mass exchange

$$E_v = m_e v_0^2 \quad \text{at the level of oscillations}$$

in the following form:

$$E_v = m_e v_0^2 = \frac{m_e^2 v_0^2}{m_e} = \frac{m_e^2 \omega_e^2 v_0^2}{(4\pi \varepsilon_0 r_e^3) \omega_e^2} = \frac{e^2}{4\pi \varepsilon_0} \cdot \frac{v_0^2}{r_e^3 \omega_e^2} = \frac{e^2}{4\pi \varepsilon_0 r_0} \quad (45)$$

The **oscillation-wave** energy of mass exchange (27) under the indicated conditions is

$$E_{vc} = m_e v_0 c \quad (46)$$

The **ratio** of the resulting **mass exchange** energies, **oscillatory** (45) and **oscillatory-wave** (46), determines the **fine-structure constant** α in the form (4), which **contains fundamental** physical **constants** (e , \hbar , и c):

$$\alpha = \frac{E_v}{E_{vc}} = \frac{v_0}{c} = \frac{e^2}{4\pi \varepsilon_0 m_e v_0 r_0 c} = \frac{e^2}{4\pi \varepsilon_0 \hbar c} \quad (47)$$

In **equalities obtained** in the WM, (45) and (47), ε_0 is the **absolute unit** of **density**, $\varepsilon_0 = 1 \text{ g} \times \text{cm}^{-3}$; and the **electron charge** $e = 1.702691627 \times 10^{-9} \text{ g} \times \text{s}^{-1}$ (22), by definition, is an **elementary quantum** of the **mass exchange rate** (discovery of WM).

Recall once again that in the **expression** (4) adopted **in physics**, the “**constant**” ε_0 is represented in the form $\varepsilon_0 = 8.854187817... \cdot 10^{-12} \text{ F} \cdot \text{m}^{-1}$. While, in fact, as mentioned above, it is **equal** to a **dimensionless number**, namely $\varepsilon_0 = 1/4\pi$.

And the **electron charge** in (4) is presented in coulombs as $e = 1.602176462 \cdot 10^{-19} \text{ C}$

Obviously, in the case of the ratio of **oscillation-wave energy** E_{vc} (46) and **wave (dynamic) energy** (32), which is equal to $E_c = m_e c^2$ under the above conditions, we **arrive** at the same formula (47).

So finally we have:

$$\alpha = \frac{E_v}{E_{vc}} = \frac{E_{vc}}{E_c} = \frac{v_0}{c} = \frac{e^2}{4\pi\varepsilon_0\hbar c} \quad (48)$$

Thus, **considering** the **energies** of the **particles** participating in the wave motion, **we come** to the **same fundamental relationships** inherent in wave processes.

Substituting further in the **expression** for α (48) the **parameters** that determine the **Dirac constant** \hbar and the **electron charge** e : $\hbar = m_e v_0 r_0$ (8) and $e = m_e \omega_e$ (42) (**discovery** of DM), we come to the equality:

$$\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c} = \frac{m_e \omega_e^2}{4\pi\varepsilon_0 v_0 r_0 c} \quad (49)$$

The **electron mass** m_e , which is **included** in the above **expressions** for the **constants** \hbar and e , and in (49), has **associated character** [3] and **determined** in the DM by the following formula:

$$m_e = \frac{4\pi r_e^3 \varepsilon_0}{1 + k_e^2 r_e^2} \quad (50)$$

where r_e – **radius** of the **wave spherical shell** of the **electron**, ε_0 - **absolute unit** of **density**,
 $k_e = \frac{1}{\lambda_e} = \frac{\omega_e}{c}$ - fundamental **wave number**, λ_e - fundamental **wave radius**.

Substituting the expression for the **electron mass** m_e (50) into the **expression** for α (49) and **taking into account** that $v_0 = \alpha c$ (48), as a result, **we finally arrive** at a previously unknown

original true form of expression for the constant α :

$$\alpha = \frac{\omega_e r_e}{c} \sqrt{\frac{r_e}{r_0 \left(1 + \left(\frac{\omega_e r_e}{c} \right)^2 \right)}} \quad (51)$$

Since the term $\left(\frac{\omega_e r_e}{c}\right)^2 = k_e^2 r_e^2 \ll 1$, it can be neglected and equation (51) takes a simplified form,

$$\alpha = \frac{\omega_e r_e}{c} \sqrt{\frac{r_e}{r_0}} \quad (52)$$

The obtained expressions for α , (51) and (52), contain wave parameters that are independent of any other constants-parameters (in opposite to the expression (4) accepted in physics) and have a clear physical interpretation in WM:

- ω_e - fundamental frequency of atomic and subatomic levels (43);
- r_e и r_0 - the radii of the wave spherical shells of the electron and proton pulsating at the frequency ω_e ;
- c - basis wave speed of propagation of disturbances in the space, surrounding the particles, caused by pulsations of wave spherical shells, is the fundamental quantum of the field of the exchange rate.

We now determine the numerical values of the constant α , which follow from formulas (51) and (52). To do this, we substitute the numerical values of the wave parameters included in the above formulas. Here they are:

The **fundamental frequency** of the **atomic** and **subatomic** levels (WM **discovery**) (43)
 $\omega_e = 1.869162559 \times 10^{18} \text{ s}^{-1}$, **speed of light** $c = 2.99792458 \times 10^{10} \text{ cm} \times \text{s}^{-1}$, **radius** of
the **wave spherical shell** of the **electron** $r_e = 4.17052597 \times 10^{-10} \text{ cm}$ (41) (also **discovery**
of WM), **Bohr's radius** $r_0 = 0.52917721092 \times 10^{-8} \text{ cm}$.

After substituting the above **data** into formula (51), we **obtain** the **following values**
for the **constant** α and its **inverse value** α^{-1} :

$$\alpha = 0.007297351695 \quad \text{and} \quad \alpha^{-1} = 137.036015 \quad (53)$$

The **obtained** α^{-1} value with **high accuracy** coincides with the **recommended** by
CODATA [14] value:

$$\alpha^{-1} = 137.035999084(44) \quad (54)$$

The **calculations** performed according to the **simplified formula** (52) give the
following value,

$$\alpha^{-1} = 136.989711 \quad (55)$$

The **data obtained** convincingly **support** the **validity** of the **formulas** for α , (51) and
(52), which **contain fundamental wave parameters** (discovered in the WM) determining
the **wave structure** and **behaviour** of particles.

8. Analysis of formulas obtained in WM for α

The **expression** (52), presented **for** α in the form, where it was taken into account that $\omega_e r_e = v_e$ is the **speed** of the **field** on the surface of an **electron wave shell** with a **radius** r_e , and the **expression** (2),

$$\alpha = \frac{v_e}{c} \sqrt{\frac{r_e}{r_0}} \quad \text{and} \quad \alpha = \frac{v_0}{c}, \quad (56)$$

determine the **ratio** between the **speeds** and **radii** of the **wave shells-surfaces** of the **electron** and **proton**:

$$\frac{v_0}{v_e} = \sqrt{\frac{r_e}{r_0}} \quad (57)$$

Indeed, when moving, the **field** of **any particle**, including an electron, is **cylindrical**, representing a **wave trajectory**, where the **speed** of the transversal **oscillatory** motion is

$$v = \frac{\omega a}{\sqrt{kr}} \quad (58)$$

Let us find the **speed** of the **field** v_e on the **surface** of the **wave shell** of the **electron** using equality (57).

Substituting the **values** of the Bohr **radius** and **speed**, $r_0 = 0.52917721092 \times 10^{-8} \text{ cm}$ and $v_0 = 2.1876911263 \times 10^8 \text{ cm} \times s^{-1}$, and also the **radius** of the **wave** spherical **shell** of the **electron**, $r_e = 4.17052597 \times 10^{-10} \text{ cm}$ (41) (obtained from the **formula** of the DM for the **mass** of particles (50)), into (57), **we come** to the following **value** of **speed** v_e :

$$v_e = \left(\frac{r_0}{r_e} \right)^{\frac{1}{2}} v_0 = 7.792757402 \times 10^8 \text{ cm} \times s^{-1} \quad (59)$$

Hence, **knowing** the **speed** v_e and **radius** r_e , **using** the **formulas** for the **electron charge** $e = m_e \omega_e$ (42) and **mass** m_e (50), taking into account that $\omega_e r_e = v_e$ and $\epsilon_0 = 1 \text{ g} \times \text{cm}^{-3}$, and neglecting the term $k_e^2 r_e^2 \ll 1$, we **find** the **value** of the **electron exchange charge**,

$$e = 4\pi r_e^2 v_e \epsilon_0 = 1.702691627 \times 10^{-9} \text{ g} \times s^{-1} \quad (60)$$

The **obtained value** of the charge **completely coincides** with the **known experimental value** of the **electron charge**, **reduced** to dimension $\text{g} \times s^{-1}$ according to the **formula**,

$$e_{WM} = e_{CGSE} \sqrt{4\pi\epsilon_0}, \quad (61)$$

for **bringing** the **phenomenological value** of the **electron charge** in units of charge in the **CGSE system** (e_{CGSE}) into **objective units** of the **charge** (e_{WM}) of the **Wave Model** [8], where $e_{CGSE} = 4.8032 \times 10^{-10} \text{ CGSE}_q$, $\epsilon_0 = 1 \text{ g} \times \text{cm}^{-3}$.

Based on the elementary **amplitude-wave relations** [1], we can write the **following equalities**:

$$\frac{v_e}{c} = \frac{r_e \omega_e}{c} = \frac{a_e}{\lambda_e} = \frac{a_e \omega_e}{c} \quad (62)$$

From these **relations** it **follows** that the **radius** of the **electron sphere** r_e is the **fundamental quantum-amplitude** of the **oscillations** of matter-space, $r_e = a_e$.

On the other hand, the **equatorial circle** of the **electron** $2\pi r_e$, as an **elementary electron wave** of the basis, **fits twice** at the **Bohr radius**, $r_o \approx 2(2\pi r_e)$, as if it were a **radial wave**. This ratio is **not accidental**. In this sense, the **nucleon sphere** is a **binary electron wave**.

9. Summary and conclusions

So, we have **reasonably well-founded arguments proving** that the **fine-structure constant** α **determines** the **scale correlation** of the **basis** and the **superstructure** of **wave processes**, in particular, the **correlation** between the **field speeds** on the **wave surfaces-shells** of the **conjugated** proton-electron **binary system** and the **radii** of **these shells**.

Ignorance of the **nature** of the **components** in expression (4), accepted in physics for α : the **fundamental physical constants** e , c and m_e (included in \hbar), as well as the **introduction** into (4) (in the SI system) of the dubious “**electric constant**” ε_0 (resulting from **manipulations** with **dimensionalities** when creating SI), still **did not allow** in principle to **understand** the **nature** of origin of the **numerical value** of the **constant** α .

The **indicated components** have a **clear physical interpretation** in WM (formulas (47) - (49)). Their **physical meaning** was **discovered** in WM (which **relies** on the **axioms** of **dialectics** [10, 15]). Namely:

- * The **constant** c is the **basis wave speed** of the **exchange** of matter-space-time at the **atomic** and **subatomic** levels (equal to the speed of light), is the **fundamental quantum** of the **field** of the **exchange rate**.

- * The **constant** ε_0 is the **absolute unit** of **density** equal to $1 \text{ g} \cdot \text{cm}^{-3}$.

- * **Mass** m_e is the **associated mass** of the **electron**.

- * The **charge** e is the **elementary quantum** of the **mass exchange rate**.

**Just the discoveries, thanks to WM, of the nature
of the above constants,
played a key role in understanding the physical meaning and nature
of the origin of the number α .**

On the one hand, the constant α represents the ratio of two characteristic speeds in the hydrogen atom, namely, the threshold oscillatory speed v_0 of the orbital electron and the basis wave speed c .

On the other hand, the fine-structure constant α , (47) - (49), is a combination of fundamental physical constants. It contains the dynamic parameters of a system of a hydrogen atom in equilibrium: e , m_e , v_0 , r_0 and c (since $\hbar = m_e v_0 r_0$).

The hydrogen atom is the simplest proton-electron system that emits electromagnetic waves under certain conditions.

Therefore, it is not surprising that the parameters making up α listed above are included in the expressions for the spectral terms of hydrogen (and hydrogen-like) atoms.

This is related, as mentioned above, with the origin of Sommerfeld's idea (first put forward by him in 1916), to consider the number obtained from the combination of fundamental parameters e , \hbar and c (4), $\alpha = 7.29735308 \cdot 10^{-3}$, as a separate constant, called alpha, characterizing the strength of electromagnetic interaction.

The **final expression** for α (51) contains only **fundamental wave parameters** (ω_e , c , r_0 and r_e), characterizing the **structure** of **wave formations** and their **behaviour**: the **fundamental frequency** ω_e and the **basis speed** c of the **wave exchange** (interaction) at the atomic and subatomic levels, as well as the **radii** of the **wave shells** of proton and electron, r_0 and r_e .

So we have
three different forms of presentation of the constant α

$$\alpha = \frac{v_0}{c}, \quad \alpha = \frac{e}{4\pi\epsilon_0\hbar c}, \quad \alpha = \frac{r_e\omega_e}{c} \sqrt{r_e / r_0 \left(1 + \frac{r_e^2\omega_e^2}{c^2}\right)} \quad (63)$$

Since $r_e^2 k_e^2 \ll 1$ (where $k_e = \frac{\omega_e}{c} = \frac{1}{\lambda_e}$) and $\omega_e r_e = v_e$, the **final expression** (third in (63)) can be **reduced** to the following **simplest form**,

$$\alpha = \frac{v_e}{c} \sqrt{\frac{r_e}{r_0}} \quad (64)$$

Equating the **expression** for α (64) with the **first one**, $\alpha = \frac{v_0}{c}$, we **arrive** at the following relation,

$$\frac{v_0}{v_e} = \sqrt{\frac{r_e}{r_0}} \quad (65)$$

We see that α is **uniquely related** to **Kepler's third law** (44), $v^2 r = \text{const}$, since **equality** (65) directly **follows from the law**.

In addition, I recall a fragment from a statement by Feynman, quoted at the beginning:

“... where this number for a coupling comes from: is it related to pi or perhaps to the base of natural logarithms? Nobody knows...”

In the framework of the Wave Model, we made the discovery that, along with the mathematical constant $\pi = 3.14159...$ and the base of the natural logarithms $e = 2.718281...$, mentioned above, in the Universe, there is one more (previously unknown) irrational fundamental constant, namely, the

Fundamental period-quantum,

$$\Delta = 2\pi \lg e = 2.72875... \quad (66)$$

This number follows from the Law of the Decimal Base (Decimal Code of the Universe), which we discovered in the framework of the WM of dialectic physics [16-20].

As it turned out, the number α is associated just with Δ .

Indeed, the cardinal number of the inverse value of the "fine-structure constant" (53),

$$\alpha^{-1} = 1.37036015 \times 10^2$$

with a sufficient degree of accuracy coincides with the measure of the fundamental half-period of the Decimal Code of the Universe,

$$\left(\frac{1}{2}\right)\Delta = \pi \lg e = 1.364376354... \quad (67)$$

And the **cardinal number** of the α^{-1} value **calculated by** the **formula** (52),

$$\alpha^{-1} = 1.36989711 \times 10^2 \quad (68)$$

also **almost coincides** with **half** of the fundamental **period-quantum**, $(\frac{1}{2})\Delta$.

The **Fundamental Period-Quantum** Δ of the **Decimal Code** of the **Universe** is the **number** that **determines** the strict **rhythm** of all processes in the **Universe**, which is in the **continuous oscillatory-wave motion**, **determines** the fundamental **wave relationships** in it, including the **relationships discussed here** related to the number α .

According to the Wave Model, the **harmonic interconnection** of all **objects**, **processes** and **phenomena** in Nature **obeys** the **Decimal Code** and is **implemented** at strictly defined **fundamental frequencies**.

**The convincing arguments presented here
in a natural and consistent way unambiguously testify
to the wave nature of the constant α .**

**In general,
all the data presented above confirm the validity
of the concepts underlying the new general theory of physics –
the Wave Model.**

Thus,

**The number α is related to the
wave parameters:**

- * **fundamental frequency** of the **atomic** and **subatomic** levels ω_e ;
- * **basis wave speed** c of propagation of **disturbances** in the **surrounding space, caused** by **pulsations** of **wave spherical shells** of the **particles** at the fundamental frequency ω_e ;
- * **radii** of **wave** pulsating **shells** of conjugate **particles** (in particular, of the proton-electron system, r_o and r_e);
- * **fundamental period-quantum** $\Delta=2\pi lge$ of the **Decimal Code** of the **Universe** (66) [20].

Summing up,
we can state that thanks to the Wave Model
of dialectical physics,
the mystery of the number α is finally revealed.

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