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On the Foundation of Quantum Electrodynamics

Constructive analysis

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http://shpenkov.com/pdf/QEDbasis.pdf

Quote from Encyclopaedia Britannica:

"***Quantum electrodynamics*** *(QED), quantum field theory of the interactions of charged particles with the electromagnetic field. It* ***describes mathematically*** *not only* ***all interactions*** *of light with matter but also those of charged particles with one another.* ***QED is a relativistic theory*** *in that Albert Einstein's theory of* ***special relativity is built into each of its equations****. Because the behaviour of atoms and molecules is primarily electromagnetic in nature, all of* ***atomic physics can be considered a test laboratory for the theory****. Some of the most precise tests of QED have been experiments dealing with the properties of subatomic particles known as muons. The magnetic moment of this type of particle has been shown to agree with the theory to nine significant digits.* ***Agreement of such high accuracy makes QED***

one of the most successful physical theories so far devised".

Opinion (highlighted in red**), constantly imposed by the media , misleads people.**

It is time to show what the QED theory represents by itself in reality.

Part 1

Erroneous initial concepts

Original concepts that laid the foundation for QED:

*1. The **formula** of the average **electric current***

$$\boxed{I=e/T_{orb}}$$

*generated by an orbiting electron in a hydrogen atom, **erroneous, as we found out**. It was used to **describe** the **Einstein-de Haas effect**.*

*2. The **electron spin** equal to*

$$\boxed{\hbar/2}$$

*__nonexistent__, __subjectively introduced__ into physics because of the **use** of the above **erroneous** formula of **electric current** at the **description** of the above **effect**.*

These were the first erroneous concepts.

Just the latter that **gave rise** to **spin-mania** and led to the **introduction** into physics of a long chain of subsequent **erroneous concepts**.

On this basis, ultimately,

Quantum Electrodynamics (QED)

was created

About the concept of electron spin $\hbar/2$

The notions of **spin** and **spin magnetic moment** (corresponding to the spin) play a **crucial role** in **electromagnetism.**

The **introduction** of the concept of spin, for the first time for an electron, **became** the **beginning** of a **wide application** of this concept in physics. **Indeed**, after the electron, the notion of **spin** was attributed to all **elementary particles**.

As a result, by the present day the physical parameters associated with the spin have **formed** in a group of the most important irreplaceable parameters of modern physics, **constituting** its **foundation** along with all other physical parameters.

Our **studies have shown**, however, that physicists made a **fundamental error**, unreasonably recognizing the **hypothetical electron spin** $\hbar/2$ (**fictional** parameter) as a **real** parameter of the electron.

Analyzing all the data related to **electron spin**, we found that **in fact** physicists

are **not** dealing with their **own mechanical** moments (**spin**) of **free electrons** and **own magnetic** moments corresponding to the spin, as they believe,

but with **orbital** mechanical and **orbital** magnetic moments of **electrons bound** to **atoms**, *i. e.*, they deal with the **magnetic** moments of **atoms**.

This **report focuses** on the **rationale** for this **discovery** and **analysis** of the **consequences** for physics **caused** by the **introduction** of the **electron spin** concept.

The **history** of introducing the concept of **electron spin** is associated with the Einstein-de Haas **experiment** on the determination of the **magnetomechanical** ratio (1915).

They relied on **Bohr's atomic model**. From their experiment it follows that the **ratio** of the ***magnetic moment*** of an **orbiting electron** to its ***mechanical moment*** **exceeded** in **two times** the **expected value** (which followed from calculations).

Calculation of the ***orbital magnetic moment*** of an electron in an atom was **carried out** according to a simple **formula**: $\mu_{orb} = (I/c)S$, where the **average value** of the **electric current** I, produced by an electron **moving** in **orbit**, was determined by the **formula**

$$I = e/T_{orb} \, ,$$

as **described** in all sources, including fundamental university **textbooks** on physics.

Our research has shown, however, that this formula is

erroneous!

Namely, ***the average current I is twice as large*****!**

This is why, the **calculated** ***orbital magnetic moment*** of the electron μ_{orb} turned out **twice less** of experimentally obtained.

To **compensate** the ***lost half*** of the ***orbital magnetic moment***, made at the calculations (caused, as we revealed, due to using the **erroneous value** of current I in the formula $\mu_{orb} = (I/c)S$),

the **concepts** of own mechanical moment (**spin**) of an electron of a relatively **huge** absolute **value** $\hbar/2$ and its corresponding (**spin**) **magnetic moment, equal to exactly the lost half,** were eventually ***subjectively introduced*** into physics. **!**

Over time, the ***opinion*** has fully **formed** that the **presence** of an **intrinsic** mechanical moment of an electron (spin) of value $\hbar/2$ is a real fact.

However, this is a sad misconception, only faith.
There is no direct evidence of this feature!

Information on the detection of the *spin magnetic moment* on *free electrons* (unbound with atoms) is absent.

I will try to explain **where** and **why** an inexcusable **error** (fateful for the development of physics) **was made,** which **led** to

introducing into physics

(**unreasonably,** as we revealed)

of the above-mentioned ***inadequate notions*** with the following **values attributed** to them:

$$\frac{1}{2}\hbar \quad - \text{ for the } \textit{electron spin},$$

and

$$\mu_{e,spin} = \frac{e\hbar}{2m_e c} \quad - \text{ for the } \textit{spin magnetic moment of an electron.}$$

As a **consequence**, the introduced **spin** concept

laid the foundation
for erroneous theoretical constructions.

On the history of introducing the concept of

Eigenvectors of an electron:

* ***spin***

and

* ***spin magnetic moment***

How did the concept of "electron spin" appear in physics?

Moreover, of such a relatively huge magnitude as $\hbar/2$.
Why huge? And what is $\hbar$?

Let's look at all this in detail:

A physical constant h, the **Planck constant**, is the **quantum of action**, central in quantum mechanics.

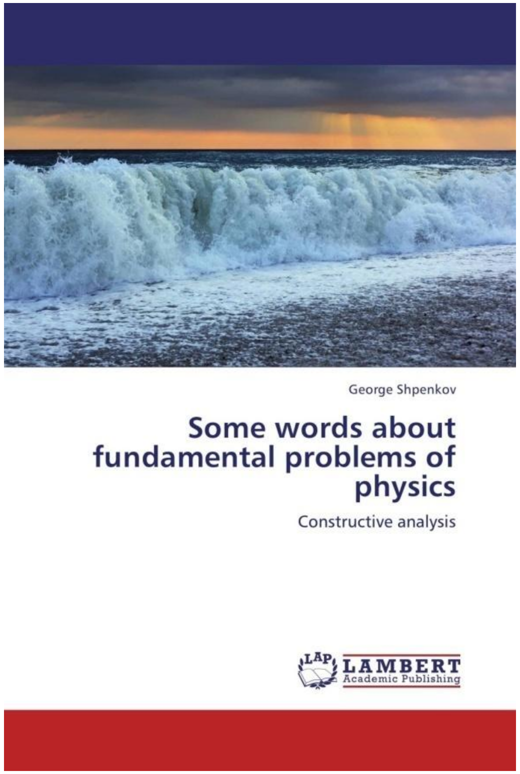
Planck's constant divided by 2π ,

$$\hbar = \frac{h}{2\pi}$$

is called the **reduced** Planck constant (or **Dirac constant**).

Both these parameters, h and $\hbar$, are **fundamental** constants of **modern physics**.

The material presented here is partially published in the book [1]



In magnitude, the constant $\hbar$ is exactly equal to the ***orbital moment of momentum*** (or **angular momentum** or **rotational** momentum) of the electron in the first **Bohr orbit**, according to the **Rutherford-Bohr** atomic model, and is a **quantum** of this **moment**:

$$\hbar = m_e \upsilon_0 r_0 \tag{1.1}$$

where m_e is the electron **mass**, υ_0 is the **first Bohr speed** of the electron moving around a proton in the hydrogen atom, r_0 is the radius of the **first Bohr orbit**.

In **quantum mechanics,** there is **no** concept of the **trajectory** of the electron motion and, correspondingly, there are **no circular orbits** along which electrons move.

Accordingly, there is **no** concept of **speed** of **motion** along orbits, just as there is **no** concept of the **radii** of such non-existent orbits.

Moreover, in **quantum theory,** according to the **uncertainty** principle, **conjugate variables** such as the particle **speed** υ and its **location** r can not be precisely determined at the same time. Therefore, the above two parameters can not be presented together in the corresponding equations of the given theory.

For the reasons stated above, formula (1.1) and the formula for h,

$$h = 2\pi m_e \upsilon_0 r_0 \,, \qquad (1.2)$$

do not make sense in quantum physics and are practically **not mentioned**.

It should be noted that in the **spherical** field of an atom the **product** of the **orbital radius** r_n and **angular velocity** υ_n of the electron is the **constant** value, $\upsilon_n r_n = const.$ Accordingly,

$$\hbar = m_e \upsilon_0 r_0 = m_e \upsilon_n r_n$$

The true, **classical origin** of the constants $\hbar$ and h is simply **hushed up**.

However, the ***history of introducing*** the concept of **electron spin** is associated with the **rotational momentum** $\hbar$ (1.1).

And **everything began** with the **Einstein** and **de Haas** experiments on the determination of the **magnetomechanical** (gyromagnetic) **ratio** (1915).

They **adhered** to the **Bohr model** of the atom [2].

<u>Very briefly</u>

Highlights of the history of introducing the concept of "spin"

From the **Einstein-de Haas** experiments it follows that the **ratio** of the ***orbital magnetic*** **moment** of the electron, moving along the Bohr orbit, $\mu_{orb,\exp}$, **to** its ***orbital mechanical*** **moment** – **moment** of **momentum**, $\hbar = m_e \upsilon_0 r_0$, is

$$\frac{\mu_{orb,\exp}}{\hbar} = -\frac{e}{m_e c} \qquad (1.3)$$

This result, as it turned out, **exceeded twice** the **expected value** (theoretical), following from the calculations:

$$\frac{\mu_{orb,th}}{\hbar} = -\frac{e}{2m_e c} \qquad (1.4)$$

(the minus sign indicates that the direction of the moments are opposite).

Being absolutely **sure** of the **infallibility** of **deducing** the ***orbital magnetic moment*** of an electron $\mu_{orb,th}$ (in (1.4)), instead of looking for an error in it (***in two times!***), the **physicists have chosen**

another way out of the situation with which they faced:

To compensate for the lost half in μ_{orb}, they **advanced** the idea that the electron **has** its ***own <u>mechanical</u> moment*** **exactly equal** to $\hbar/2$.

If only such a moment actually exists, consequently, an **electron** as a charged particle must also **have** its ***own <u>magnetic</u> moment*** **corresponding** to the ***own mechanical moment*** $\hbar/2$.

Following the **hypothesis** of Uhlenbeck and Goudsmit (1925), the own mechanical moment, assigned to an electron of the value $\hbar/2$, **was called** the **electron spin**.

Thus, the **following** (suitable for matching (1.4) with (1.3)!) **spin magnetic moment, corresponding** to the electron **spin** of the value $\hbar/2$,

$$\mu_{e,spin} = -\frac{e\hbar}{2m_e c}, \qquad (1.5)$$

was ***<u>subjectively</u> attributed*** to the electron.

In this way, the "**lost half**" of μ_{orb} in the theoretically obtained ratio (1.4) was allegedly "**found**“: $\mu_{orb} = \mu_{orb,th} + \mu_{e,spin} = \mu_{orb,\exp}$.

Ultimately, having decided that the problem was solved, the ***invented spin concept*** was **adopted** in physics.

Subsequently, the **absolute value** of the "***spin***" ***magnetic moment*** of the electron was **taken** as the ***unit of the elementary magnetic moment*** under the name the **Bohr magneton**, μ_B :

$$\mu_B \equiv \left|\mu_{e,spin}\right| = \left|\mu_{orb,th}\right| = \frac{e\hbar}{2m_e c} \qquad (1.6)$$

Thus, introducing the above **postulate** about the **spin** of the electron and with the help of a **frank fitting** of the magnitude of the spin (**exactly equal** to $\hbar/2$), physicists **compensated** in this way the corresponding **lost half** of the orbital magnetic moment in Eq. (1.4).

As a result **they** have **come** to the **desired gyromagnetic ratio**, coinciding with the ratio (1.3) obtained from the experiment:

$$\boxed{\frac{\mu_{orb}}{\hbar} = \frac{\mu_{orb,th} + \mu_{e,spin}}{\hbar} = \frac{\mu_{orb,\exp}}{\hbar} = -\frac{e}{m_e c}} \qquad (1.7)$$

Let us **return** to the **relation** (1.4), **derived** by **theorists**, which contradicts the experimental one (1.3) due to the presence of the **number 2** in the denominator of the formula for $\mu_{orb,th}$ (1.6):

$$\mu_{orb,th} = \frac{e\hbar}{2m_e c} = \frac{\upsilon_0}{2c} e r_0 \, . \qquad (1.8)$$

I'll show **where** a **blunder was committed.**

Calculation
of the orbital magnetic moment of an electron in an atom

was carried out (as **described** in the literature, including **textbooks** on physics) according to a simple **formula**,

$$\boxed{\mu_{orb} = \frac{I}{c} S} \qquad (1.9)$$

which determines the **magnetic moment** of a **closed** electric **circuit**, where S is the **area** of the orbit, c is the **speed** of **light**, and I is the **mean value** of the **circular current**.

Following the **definition** of the current used in electrical engineering as a **flow** of **electric charge** ("electron liquid") in a conductor, the **average value** of the electric **current** I produced by an electron moving in **orbit** was determined by the formula

$$\boxed{I = \frac{e}{T_{orb}}} \qquad (1.10)$$

where T_{orb} is the **period** of **revolution** of an electron (with charge e) **along** the **orbit**.

Thus, on the basis of (1.9) and (1.10), physicists have come to the **expression** (**erroneous**, as we found out):

$$\mu_{orb,theor} = \frac{I}{c}S = \frac{1}{c}\left(\frac{e}{T_{orb}}\right)S = \frac{1}{c}\left(\frac{e\upsilon_0}{2\pi r_0}\right)\pi r_0^2 = \frac{e\hbar}{2m_e c} \qquad (1.11)$$

Question:

Where should we look for the error made in (1.11) ?

The answer is obvious:

In the average value of the electric current I (1.10), used in (1.11).

Physicists ***could*** and ***should have verified carefully*** the ***suitability*** of the equation (1.10) $I = e / T_{orb}$ (for a **current** generated by a **single** electron **moving** in an **orbit**), following, as they believed, from the **general definition** of the current, expressed by Eq. $I = \Delta q / \Delta t$.

However, being ***absolutely confident*** and ***in no way doubting*** Eq. (1.10), they ***did not verify*** it, unfortunately.

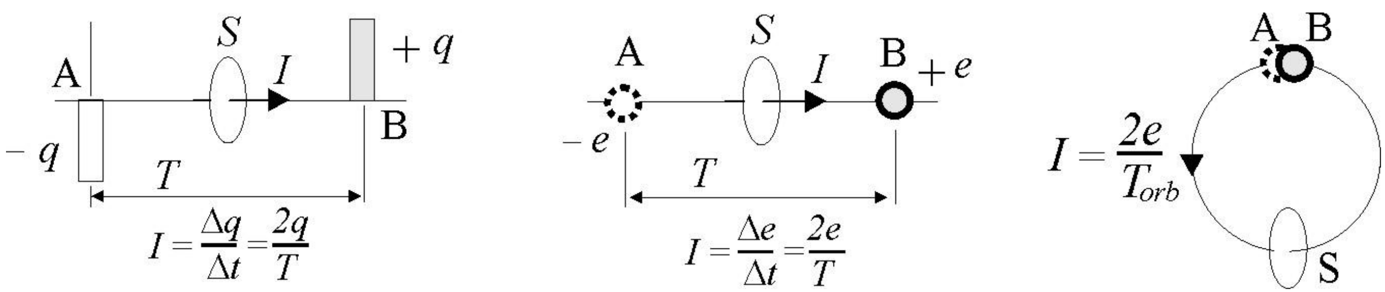
We have **filled this gap.**

Consider

What is the true average value of the current I ?

(created by a discrete (single) elementary charge e moving along a closed trajectory)

In a **general case**, the **transfer** of a charge e of an electron through any **cross section** S along any trajectory is accompanied by its **disappearance** from **one** side (-e, point A) of an arbitrary **cross section** and the **appearance** on the **other** side (+e, point B), as shown in **Figure**:



So, the **disappearance** of the charge on the **left** side of the cross section means a **decrease** in charge to the **left** of + e to zero, $i.$ $e.$, by an amount -e.

And the **appearance** of a charge on the **right** side of the section means an **increase** in charge to the **right** of zero to + e, $i.$ $e.$, on the value of + e.

Thus, during the time T, the **total change** in charge is $\Delta q = +e - (-e) = 2e$.

Hence, the **average rate** of **change** of the **charge** (**current** I) during the time T is

$$I = \frac{\Delta q}{\Delta t} = \frac{e-(-e)}{T} = \frac{2e}{T} \qquad (1.12)$$

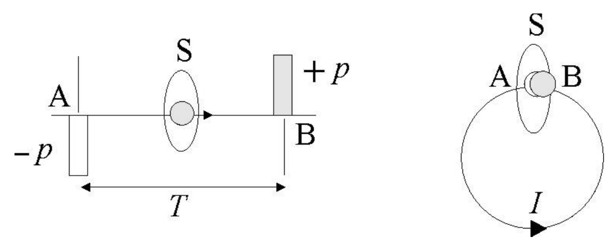
And in the case of a **circular orbit**, when the points A and B coincide, an electron having a **charge** e **passes** through the cross section S with an **average speed**

$$\boxed{I = \frac{2e}{T_{orb}}} \quad ! \qquad (1.13)$$

where T_{orb} is the **period** of **revolution** of an electron in a **circular** orbit.

Generally, the **transfer** of any **property** of some object (a parameter of exchange p) is **characterized** by the **average rate** of **exchange** I, determined by the expression

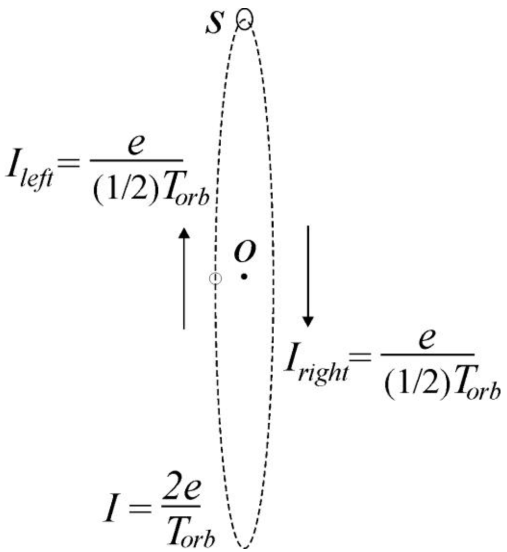
$$\langle I \rangle = \frac{2p}{T}$$



We **can** also **come** to **formula** (1.13) **without violating** the generally accepted **definition** of the concept of current intensity by the following way:

Let's **transform** the circular **orbit** into eliptical, as shown in the figure.
We get a **two-wire closed loop**.

Current in a two-wire closed loop:



An electron, moving along the closed circuit (**during one full revolution** T_{orb}) passes in the immediate vicinity of the point "O" **two times**: first, **moving up** (average current on the **left** half of the trajectory $I_{left} = e/(1/2)T_{orb}$), and then **moving down** (the average current on the **right** half of the trajectory $I_{right} = e/(1/2)T_{orb}$).

Thus, the electron **two times** creates a transverse (vortex) **magnetic field** at this point: **first**, passing along the **left**, and then along the **right** side of the trajectory from its centre "O".

With this, the **conventional formula**, which follows from the **definition** of the mean value of the **current intensity** $I = \Delta q/\Delta t$, adopted in physics, is **not violated**.

Both from the **left** and **right** sides, and consequently, **along** the **entire** closed **circuit**, the **average current** is the **same**; it is equal to:

$$\boxed{I = I_{left} = I_{right} = \frac{2e}{T_{orb}}} \qquad (1.14)$$

An **electron**, like any other elementary particle, manifests **duality** of behaviour, both **particles** and **waves**. Therefore,

we should derive the formula
for the mean value of the current also
for the case of the wave motion of an electron.

To do this, firstly, it is necessary to determine the **relationship** between the **period** of **revolution** T_{orb} and the **wave period** T_0.

One-dimensional case:

From the well-known solution of the wave equation for a **string** of length l fixed at both ends, it follows that only **one half-wave** of the fundamental tone is **placed** at its **full length**, *i. e.*, $l = \lambda_1 / 2$.

If we **connect** the **ends** of the string **together**, then a **circle** with a length of $l = 2\pi r_0$ with one node is formed.

As a **result**, we arrive at the equality:

$$2\pi r_0 = l = \frac{\lambda_1}{2} = \frac{\upsilon_0 T_0}{2} \quad \rightarrow \quad T_0 = \frac{4\pi r_0}{\upsilon_0} = 2T_{orb} \qquad (1.15)$$

where υ_0 is the **wave speed** in the string, T_0 is the ***wave period***, T_{orb} is the ***period*** *of* ***revolution***.

In the simplest **three-dimensional** case of solving the wave equation for a **spherical** field [3], we arrive at the **same equality** (1.15):

only one half-wave ($\lambda_1/2$) of the fundamental tone is placed on the Bohr orbit (of the length $2\pi r_0$) and the electron is in the node of the wave.

Thus, the ***wave period*** T_0 of the fundamental tone on the wave surface of radius r_0 is **equal** to the **time** of ***two full revolutions*** along the orbit: *i. e.*, equal to $2T_{orb}$,

$$T_0 = 2\left(\frac{2\pi r_0}{\upsilon_0}\right) = 2T_{orb} \tag{1.16}$$

The average value of electrical current,

as a harmonic quantity, is determined by the known formulas:

$$I = \frac{2}{iT}\int_0^{T/2} I_m e^{i\omega t}\,dt = \frac{2}{\pi}I_m \quad \text{or} \quad I = \frac{1}{2\pi i}\int_0^{2\pi} I_m e^{i\varphi/2}\,d\varphi = \frac{2}{\pi}I_m \tag{1.17}$$

The **amplitude** of the elementary current I_m entering the expression (1.17) is

$$I_m = \left(\frac{dq}{dt}\right)_m = \omega_0 e = \frac{2\pi e}{T_0} \qquad (1.18)$$

where ω_o is the **frequency** of the **fundamental tone** of the electron orbit.

Substituting (1.18) into (1.17), we obtain

$$I = 4e / T_0 \qquad (1.19)$$

Or, **since** $T_0 = 2T_{orb}$ (see (1.16)),

$$\boxed{I = 2e / T_{orb}}\ \mathbf{!} \qquad (1.20)$$

The **true value** of the **average current** (1.20) is **twice** the **value** $I = e / T_{orb}$ (1.10) **used** by theorists in **formula** (1.9) when **calculating** the **orbital magnetic moment** of the electron μ_{orb} at describing the Einstein-de Haas effect.

Surprisingly, so far almost for a **century, no one paid attention** to the **formula** of the **average value** of electric **current** I produced by an **orbiting electron** [3, 4]**!** Didn't see the **gross error** contained in it?

Thus, the error was found !

Substituting the **true value** of the **average** current (1.20) into the formula (1.9), we arrive at the **true value** of the **orbital magnetic moment** of the electron:

$$\boxed{\mu_{orb} = \frac{I}{c}S = \frac{1}{c}\left(\frac{2e}{T_{orb}}\right)\pi r_0^2 = \frac{\upsilon_0}{c}er_0} \quad \text{or} \quad \boxed{\mu_{orb} = \frac{e\hbar}{m_e c}} \tag{1.21}$$

Hence, the **true ratio** of the **orbital magnetic** moment of the electron μ_{orb} (1.21) to its **mechanical moment** $\hbar = m_e \upsilon_0 r_0$ (**orbital angular momentum**), taking into account the **sign** (the **opposite** direction of the moments), is equal to

$$\boxed{\frac{\mu_{orb}}{\hbar} = -\frac{\upsilon_0 e r_0}{c m_e \upsilon_0 r_0} = -\frac{e}{m_e c}} \tag{1.22}$$

The **obtained** ratio of the moments (1.22) **coincides** with the **ratio** of the moments (gyromagnetic ratio) (1.3), which was **observed experimentally** in the Einstein-de Haas experiments and in Barnett's experiments.

By the way, the **true value** of the **own** magnetic moment of an electron is **negligibly small** in **comparison** with the value **assigned** to it **subjectively** in half of the orbital magnetic moment. What is its specific value and how it was calculated can be found in [5].

An interesting example for a greater understanding

of the degree of meaninglessness of introducing the electron spin $\hbar/2$

For the **Earth**, the **own** (“**spin”**) and **orbital** moments of momentum are equal, respectively, to:

$$L_{own,Eth} = J \cdot \omega = (2/5)MR_{Eth}^2\omega = 7.07 \cdot 10^{33}\, kg \cdot m^2 \cdot s^{-1}$$

and

$$L_{orb,Eth} = MVR_{orb,Eth} = 1.12 \cdot 10^{39}\, kg \cdot m^2 \cdot s^{-1}$$

The **ratio** of the above moments is

$$L_{own,Eth} / L_{orb,Eth} = 6.3 \cdot 10^{-6}$$

Imagine that the **own moment** of **momentum** of our **Earth** has become equal to **half** of its **orbital** moment of momentum, *i. e.*,

$$L_{own,Eth} / L_{orb,Eth} = 1/2$$

The period of revolution T_{own} of the Earth in this case would be about

$$T_{own} = 4\pi \cdot J / L_{orb} \approx 1.091 s$$

(as against $T_{own,Eth} = 86400\, s$ that is in reality).

The Earth **will not be able** to **withstand** such a **huge** own moment of momentum (“spin”) and will be **destroyed.**

Existence of an **electron** (**regardless** of a permissible **size** that would have been **attributed to it**) with "spin" equal to $\hbar/2$ is also (like Earth with $L_{own} = L_{orb} / 2$) **impossible**.

Estimated in the Wave Model [5], **own (spin) magnetic** moment of an electron is **insignificant**,

$$\mu_{spin} = 5.609964 \cdot 10^{-29}\ J \cdot T^{-1}$$

as **against orbital** one,

$$\mu_{orb} = 1.855877461 \cdot 10^{-23}\ J \cdot T^{-1}$$

Thus,

$$\mu_{spin} / \mu_{orb} = 3.0 \cdot 10^{-6}$$

As we can see, the ratios of the above **moments** (own, "**spin**", to **orbital**) for **both** the orbiting **electron** and for the **Earth** are insignificant, have the **same order** of magnitude, **10^{-6}**.

All **details** about the issues discussed in this report can be found in the **Lectures** of the author on the **Wave Model** [6].

Part 2

Subsequent fictional concepts

The g-factor
and
anomaly
of the electron spin magnetic moment

A **mistake** in **two times**, made in the **derivation** of the **orbital magnetic moment** of the electron $\mu_{orb,th}$,

led to a whole series of postulated concepts.

One of them is the **concept** of

g-factor

According to the **original definition**, the g-**factor** is a multiplier, which connects the **gyromagnetic ratio** of the particle γ obtained **experimentally** with the value of the **gyromagnetic ratio** γ_0, obtained **theoretically** (erroneous, as we have shown), following (as it was thought) the **classical theory**:

$$\gamma = g\gamma_0 \tag{2.1}$$

The **gyromagnetic ratio** γ for an **electron**, following from the experiment (of Einstein-de Haas, Barnett et al.) [7], is

$$\gamma = \frac{\mu_{orb,\exp}}{\hbar} = -\frac{e}{m_e c} \tag{2.2}$$

The **theoretical** value γ_0 , obtained in describing this effect, is **twice smaller**, *i. e.*, equal to

$$\gamma_0 = \frac{\mu_{orb,th}}{\hbar} = -\frac{e}{2m_e c} \tag{2.3}$$

Thus, as follows from the **above definition** of the g-**factor,** for an **electron** it is equal to the number 2:

$$g = 2 \qquad (2.4)$$

According to the definition, accepted in modern physics,

the so-called **general** g-**factor** is a factor connecting the **gyromagnetic ratio of a particle** γ **with** the ***classical value*** of a gyromagnetic ratio γ_0:

$$\gamma = g\gamma_0$$

As we see, the **mistakenly calculated** value $\gamma_0 = \left(\frac{1}{2}\right)\frac{q}{mc}$ (2.3) is **considered in physics** as a **matter of course** the "***classical value***" of the gyromagnetic ratio.

Obviously, this means a **lack** of **understanding** of the **fallacy** of the relation (2.3).

The g-factor is, in essence,
an indicator of the mistake, its degree,

made at the **theoretical derivation** of the **orbital magnetic moment** of an electron, and nothing more.

Hence, the **assignment** (by ignorance) a certain **physical meaning** ("***classical value"***) to the relation (2.3) is unreasonable and erroneous.

The **experimental** value of the magnetic moment of an electron in the Bohr orbit, which was **determined** more **accurately** over time, $\mu_{orb,\exp}^{updated}$, ***slightly differs*** from the value obtained in the initial experiments,

$$\mu_{orb,\exp}^{updated} > \mu_{orb,\exp} = -\frac{e}{m_e c}\hbar = -\frac{\upsilon_0}{c} e r_0 \qquad (2.5)$$

where $\hbar = m_e \upsilon_0 r_0$.

This **small** deviation (**increase**) was called an **"*anomaly*"**.

Recall, the **total magnetic moment** of the electron (μ_{orb}) in the Bohr orbit consists, as was accepted in physics, (**in half**) of the **orbital magnetic moment** (**erroneously calculated,** as we have shown [7, 8]) ,

$$\mu_{orb,th} = \tfrac{1}{2}\mu_{orb,\exp}\,, \qquad (2.6)$$

and (**in half**) of the **own** ("**spin**") **magnetic moment** (**attributed** to the electron) also equal to $\mu_{orb,th}$,

$$\mu_{e,spin} = \mu_{orb,th} = \tfrac{1}{2}\mu_{orb,\exp} \qquad (2.7)$$

The term $\mu_{e,spin}$ is equal to the **lost half** of the **orbital magnetic moment** μ_{orb}**.** It was introduced to **compensate** for the **mistake** in calculations of μ_{orb} in two times. Thus, it was accepted that

$$\mu_{orb} = \mu_{orb,th} + \mu_{e,spin} = \mu_{orb,\exp} = -\frac{e}{m_e c}\hbar\,, \qquad (2.8)$$

Because of the "anomaly“, $g_e > 2$

In **quantum mechanics** (QM), **probabilistic** in nature, which replaced the theory of the Rutherford-Bohr atom, there is **no** concept of **orbital motion**.

Therefore, it was **suggested** (and further **accepted**) that the “**anomaly**” **concerns** the ***spin component*** ($\mu_{e,spin}$) of μ_{orb}: the property inherent, as believed, in a **free electron**.

For convenience, in physics it **was customary** to express the "**anomalous**" magnetic moment of a **free electron** using the parameter α_e (called **“anomaly”**) defined by the following equality:

$$\alpha_e = \frac{g_e - 2}{2} \qquad (2.9)$$

Taking into account (2.9) and the **value** of the **intrinsic** angular momentum of the electron (**spin**), equal, as was accepted, to **half** of the **orbital moment of momentum**, $\hbar / 2 = (1/2) m_e \upsilon_0 r_0$, the expression for the **spin magnetic moment** of the electron is given in the following form :

$$\mu_{e,spin} = -g_e \frac{e}{2m_e c}\left(\frac{\hbar}{2}\right) = -\frac{g_e}{2}\mu_B = -\mu_B(1+\alpha_e) \qquad (2.10)$$

What can be the cause of disturbances of a free (as believed) electron resulting in the “anomaly” α_e of its own (spin) magnetic moment?

Virtual particles

Influence of intra-atomic dynamics

of constituent **particles** (nucleons and electrons) each separately and **bonds** between them was **excluded from possible causes**, since this is not a feature of the behaviour inherent in the atom, according to the **existing concept** about its structure.

An **atom** was considered as the **centrally symmetric system**, consisting of a tiny superdense **nucleus** (containing protons and neutrons) and electrons, moving around (indefinitely, how), **obeying** the **probabilistic laws** of quantum mechanics.

For example, the simplest nucleus of the hydrogen atom, a **proton**, was considered in the form of a **rigid** compact **static formation,** similar to a **solid spherical** micro object of **giant density**, on average about $4 \times 10^{14}\ g \cdot cm^{-3}$, and 10^5 times **smaller** in size **than** the **atom**.

Despite the **absurdity** of the existing **model** of the atom, it was/is **not questioned** by official physics and **no attempts** were/are made to **revise** it.

Physicists-theorists suggested that the perturbing impact on a free electron, resulting in the "anomaly" of its own ("spin") magnetic moment,

is due to the influence of virtual particles.

In accordance with the postulate on "virtual" particles:

Any ordinary particle continuously
emits and **absorbs** virtual particles of various types.

And the **interaction** between them is described in terms of the **exchange** of **virtual particles**.

In particular, the **electromagnetic** repulsion or attraction **between charged particles** is considering as due to the **exchange** of many **virtual photons** between the charges.

The **physical** state of **vacuum** is also associated with continuously **generating** and **absorbing** virtual particles in the field-space of the vacuum.

The process of the **appearance** and **disappearance** of particles lasts so short time interval (about 10^{-24} s), so that **no detectors** can **find** such **particles** in principle, hence the name – ***virtual*** (**imaginary**, that is, in fact, **unreal**) [9].

It was accepted to consider that
an electron emits and absorbs virtual photons,
which **change** the **effective electron mass.**
As a result, this **influence**s on the electron **own** ("spin") **magnetic moment** and **leads** to its "**anomaly**".

A phenomenon called the Lamb shift [10] (the **shift** of the *s*- and *p*-levels) is considered **also**, as it is commonly believed, as the **result** of the **interaction** between the **electron** moving along the **orbit** and the **virtual particles,** which are "**swarming**" in the surrounding **vacuum**.

Due to quantum **fluctuations** of the **zero field** of the **vacuum**, continuously **generating** and **absorbing** virtual particles, the **orbital motion** of an electron in an atom is **subject to** additional **chaotic motion**.

Thus, in order to explain the small but noticeable perturbations in the motion of an electron, resulting in the "anomalous" magnetic moment of the orbiting electron and the hyperfine structure of the energy levels of hydrogen and deuterium (the Lamb shift), the postulate on virtual particles was invented.

The latter was **accepted** as **one** of the fundamental postulates in the developing **quantum field theory**.

Currently, a virtual particle is **defined** in physics as a **transient fluctuation** that exhibits some of the characteristics of an ordinary particle, but whose **existence** is **limited** by the **uncertainty principle**.

Dirac equation

Thus, after the **introduction of** the **postulate** on the ***electron spin*** $\hbar/2$, a **whole series** of **concepts**, **related** to the ***spin***, was **invented** and **introduced** into physics. **So, we have**:

"***Electron spin"***

"Electron spin g-factor"

"Anomaly" of the electron spin magnetic moment,

"***Classical value"*** for the gyromagnetic ratio,

"General g-factor" for elementary particles,

"Virtual particles".

In 1928, **Dirac** took the next steps in the same direction.

Knowing the problems faced physics at that time, combining **quantum mechanics** and **relativity**, **Dirac tried to rebuild** the **Schrödinger equation** (invented in 1926) in such a way that the **existence** of the **electron spin would follow** from its solutions.

As a **result,** the so-called relativistic **generalization** of the **Schrödinger equation,** the **Dirac equation, appeared** in physics.

Recall, **Schrodinger's equation** is the main equation of **quantum mechanics** (QM), and is **one** of its **six** basic **postulates**.

Schrodinger's equation
(QM postulate)

Dirac's equation
(QED postulate)

(2.11) $$i\hbar\frac{\partial\Psi}{\partial t}=\hat{H}\Psi$$

(2.12) $$\hat{H}=\frac{1}{2m}\hat{\mathbf{p}}^2+U(r,t)$$

⇦ Compact forms ⇨

$$i\hbar\frac{\partial\Psi}{\partial t}=\hat{H}\Psi \qquad (2.13)$$

$$\hat{H}=c\boldsymbol{\alpha}\hat{\mathbf{p}}+mc^2\beta \qquad (2.14)$$

We see that **Dirac** and **Schrodinger** equations have **the same compact form**, the **difference** in Hamilton operators.

For **particles moving in an electromagnetic field**, the corresponding **Hamiltonians** are representing as follows:

(2.15) $$\hat{H}=\frac{1}{2m}\left(\mathbf{p}-\frac{e}{c}\mathbf{A}\right)^2+e\varphi$$

$$\hat{H}=c\boldsymbol{\alpha}\left(\mathbf{p}-\frac{e}{c}\mathbf{A}\right)+e\varphi+mc^2\beta \qquad (2.16)$$

$\boldsymbol{p}$ is the operator of a generalized momentum of a particle, $\mathbf{A}$ and φ are vector and scalar potentials , e – particle charge, $\boldsymbol{\alpha}$ – vector operator, β – operator not contained coordinates.

So, combining **quantum mechanics** and **relativity**, Dirac **generalized** the Schrödinger **equation** by **changing** its Hamiltonian.

He began to **rebuild** the **Hamiltonian** in the equation in such a way that **between** $\hat{H}$ and **operators** of **momentum** the **same relation** will **remain** that exists **between energy** and **momentum** in the theory of **relativity**, that is,

$$\hat{H}^2 = c^2(\hat{p}_x^2 + \hat{p}_y^2 + \hat{p}_z^2) + m^2c^4 \qquad (2.17)$$

This **requirement** ultimately led to the introduction of special operators, α and β, and the operator $\hat{H}$ took the form (2.14).

Solving the obtained equation,

Dirac came, in result, to the absurd conclusion about the existence of

negative kinetic energy.

This led to very serious consequences for physics, one of which is the **Electron Theory of Solids** (the latter is subject to special consideration).

Relativistic expression for **energy**,

$$E^2 = c^2 p^2 + +m_0^2 c^4 \tag{2.18}$$

(taken into account in the Hamiltonian of the Dirac equation), **admits two equitable solutions**:

$$E = \pm\sqrt{c^2 p^2 + m_0^2 c^4} \tag{2.19}$$

Their difference, at p=0, formally defines the **minimal difference** of **energies** equal to $2m_0c^2$:

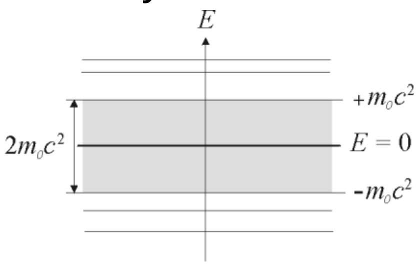


Fig. The formal levels of **kinetic energy**, divided by the interval of $2m_0c^2$.

According to **relativity** theory, only the **relative motion exists** in nature, where the **rest** is **excluded**, accordingly, the **potential energy** is **impossible**.

This **peculiarity** of **Einstein's relativism** one should regard as the **coarsest distortion** of the **real nature** of any processes.

Keep in mind that **according to dialectics** [11], which represents a **synthesis** of the **best achievements** of both **materialism** and **idealism**, and is the **ground** for **understanding** the **material-ideal essence** of the world, the **motion** is **absolute-relative**.

According to Einstein, **solution** (2.19) **determines** the **kinetic energy**.

Therefore, Dirac interpreted the energy with a minus sign,

$$E = -\sqrt{c^2 p^2 + m_0^2 c^4}\,, \qquad (2.20)$$

as negative kinetic energy.

He supposed, further, that **all states** with the **negative energy** are **occupied** with **electrons**.

He put forward this supposition because of that simple reason that **he plainly did not know in earnest**, what one should make with the **negative** energy.

However, **why** should **negative energies** be inherent **only** to **electrons** in the entire Universe?

There is **not** a single-valued **answer** to this question, because **such** a **version** of filling the energies is **strikingly primitive**.

But, as Dirac has assumed, **this model** has **excluded** the **transition** of **particles** in the **states** with the **negative energy**, which **were** already **occupied**.

From the **formal point** of view, when there is no clear understanding of the problem in question, **interpretation** of the **negative** sign of **energies** has **required introducing** the **negative mass** or the **charge** with the **opposite sign**.

Such an object became to be **regarded** as a “**hole**” in the space of matter...

Introducing the **equations** in any theory, it is **not so easy** to **guess** beforehand **what signs** of kinetic and potential energies **will arise** from their **solutions**.

One should clearly **understand** that **any** algebraic or differential **equation** is **indifferent** to our views on **either sign** of parameters, which **originates** from the equation.

Unknowing the philosophy of signs, **Dirac made** the simplest and **wrong decision**.

As a result, **Dirac's** erroneous ideas **gave birth** to the **theory** of the **electromagnetic vacuum**, perhaps the **most primitive** mechanical **theory** of the field of matter-space-time.

This **theory** formally **led** to the **conclusion** that **there are electrons** with **positive** charges, that is, **positrons**.

The **world**, as a **system** of **oppositions**,

does not require equations for confirmation of the fact

that **oppositions really exist**.

But, unfortunately, the **discovery** of **positrons** was **regarded** as a **triumph** of **Dirac's theory**, although, his **erroneous interpretation** of the **negative** sign of **energy**, in essence, **had no relation to the positron**.

Dirac also stated that **electron spin** $\hbar/2$, **non-existent**, as we have convincingly shown (discussed in Part 1), **allegedly follows** from solutions of his equation.

Since then, it is commonly **believed** that the electron spin $\hbar/2$, previously introduced subjectively to a free (unbounded) electron at the description of the Einstein-de Haas effect, really **follows** directly **from Dirac's equation**.

Some comments about this:

The problem associated with the lost half of the angular momentum $\hbar/2$, which led to the above conclusion, arose, naturally, when solving the Dirac equation.

Let's see how it was resolved.

One of the **main faults** of the **Dirac theory** is the sad **fact** that **binary potential-kinetic nature** of physical **processes** and, hence, the **presence** of **binary parameters** characterizing their course, were **not taken into account**.

Hence, **potential** and **kinetic energy** were interpreted by Dirac erroneously, as **positive** and **negative** **<u>kinetic</u>** energy (that seriously affected the development of physics).

Further more. As a **consequence**, Dirac came to an **erroneous result** also in the next case.

When he **composed** the **operator** of **moment** of **momentum** $\hat{\boldsymbol{L}} = [\hat{\boldsymbol{r}}\hat{\boldsymbol{p}}]$, the binary **potential-kinetic nature** of the particle **speed** $\hat{\upsilon} = d\hat{\Psi}/dt$, **caused** by the **potential-kinetic nature** of the **displacement** $\hat{\Psi} = \Psi_p + i\Psi_k$, has **not been taken into account** in the **operator** of **momentum** of a particle, $\hat{\boldsymbol{p}} = m\hat{\upsilon}$.

Therefore, **since** the $\hat{\boldsymbol{p}}$ **operator** did not contain the **potential** (normal) **component** υ_p of the operator of **velocity vector** $\boldsymbol{\upsilon}$, the **operator** of **angular momentum** $\hat{\boldsymbol{L}}$ was, naturally, **incomplete**.

For this reason, of course, the **incomplete operator** $\hat{\boldsymbol{L}}$ did not commute with the Hamiltonian $\hat{\boldsymbol{H}}$ (2.14), what really happened, that is,

$$\hat{\boldsymbol{H}}\hat{\boldsymbol{L}} - \hat{\boldsymbol{L}}\hat{\boldsymbol{H}} \neq 0 \tag{2.21}$$

This means that **moment** of **momentum** $\boldsymbol{L} = \boldsymbol{r} \times m\upsilon$ is **not an integral of motion** and is **not preserved**. In other words, the **law of conservation of angular momentum** for such a moment is **not respected**.

It **would be naturally** to turn attention to the **velocity vector** $\boldsymbol{\upsilon}$ and its **components** in the **angular momentum**, since all projections of the latter are **testing** on **commuting** with the Hamiltonian.

However, to **find** a **way out** of the situation, **Dirac went** the **other way, introducing** a new **operator** $\hat{\boldsymbol{j}} = \hat{\boldsymbol{L}} + \hat{\boldsymbol{s}}$, where $\hat{\boldsymbol{s}}$ is some **unknown operator**, additional to the first one.

Note that to that time **Dirac knew** about the **hypothesis** about the **electron spin** $\hbar/2$, put forwarded in 1925 by **Uhlenbeck** and **Goudsmit** to describe Einstein-de Haas effect.

Searching the **condition**, at which the **new** operator $\hat{\boldsymbol{J}}$ **will be commuted** with Hamiltonian, **Dirac found** that eigenvalues of the operator $\hat{\boldsymbol{s}}^2 = \hat{s}_x^2 + \hat{s}_y^2 + \hat{s}_z^2$ have the form:

$$\left(3/4\right)\hbar^2 \tag{2.22}$$

From (2.22) **it follows** that the **value** of the **additional** (to the incomplete $\boldsymbol{L}$) **moment** of **momentum** of a particle (its projection in a certain direction) is **equal** to $\hbar/2$.

The obtained value $\hbar/2$ **represents half** the **orbital moment** of **momentum** of the electron in the first Bohr orbit, which is equal to

$$\hbar = m_e v_o r_o.$$

Since in a spherical field $v_n r_n$ = const, for a **particle** with **mass** m moving with speed v, the **angular momentum** is

$$L = mvr = mv_o r_o,$$

Although there were no any **convincing arguments** to **assert** that the value $\hbar/2$ **relates** to the **hypothetical electron spin** (**non-existing**, as we now know), **nevertheless**,

Dirac associated the obtained value of $\hbar/2$ just with

the hypothetical **proper moment of momentum** of an electron **– spin –** thereby **confirming** the above hypothesis.

This decision was **unfounded**. **Dirac took wishful thinking**.

Subsequent calculations
showed erroneousness of this decision.

Namely, calculations have **shown** that electron spin with value $\hbar/2$, **subjectively introduced** as additional **mechanical parameter** to compensate the **lost half** of the angular momentum (**mechanical parameter)**,

cannot be identified in the classical sense,
as a parameter
associated **with mechanical rotation** of the electron along its axis.

An electron **cannot withstand such a giant proper angular momentum** (if the latter could really exist) as $\hbar/2$. **Equal** to **half** the **orbital angular momentum**, own moment of $\hbar/2$ will **destroy** the electron, regardless of size ascribed to it.

However, physicists of that time **liked** the idea of the **electron spin** so much that they did not want to part with it and **invented** a **new physical meaning** for it.

So, by accepted definition, electron spin
became considered as some <u>inner quantum property</u>
("intrinsic", non-mechanical)
inherent in a particle
additionally to such basic properties as mass and charge.

Eigenvalues of the operator (2.22) $\hat{\boldsymbol{s}}^2 = \hat{s}_x^2 + \hat{s}_y^2 + \hat{s}_z^2$ began to represent in the form:

$$\hbar^2 s(s+1) \tag{2.22a}$$

where $s = 1/2$ was called an **intrinsic** or **spin quantum number** of a particle. Now it is **this number** (1/2) that is **usually called** the **spin** of the particle …

Surprisingly, **as time has shown**, no one thought about the **correctness** of the accepted decision.

The **subjective** introduction of a new **fictional notion** showed a complete **lack** of common sense **logic** in the **hypothetical** theoretical constructions of physicists of that time.

The fictional intrinsic “quantum” parameter

(non-material, **intangible**), which was **attributed** to the electron cannot **affect** the value of the angular (**rotational**) momentum $\boldsymbol{L}$ of the **orbiting particle** regardless of the magnitude attributed to such a quantum parameter.

Therefore, considering the spin actually as a kind of indefinite **inner property** (the definition a "**quantum property**" doesn't clarify anything), it is **pointless** to **add** it (a **fictional parameter** not related to real spinning) to the **real mechanical** angular momentum $\boldsymbol{L}$,

which characterizes the motion of a particle as a whole

and depends on the **real** parameters such as
distance r, **mass** m and **speed** v of the particle.

Obviously, and this follows from our research,

The value of $\hbar/2$ obtained by Dirac

is

that half of the orbital moment of momentum of an electron,

which by ignorance was not taken into account in the calculations

We will show this

(The lost of half of the ***orbital magnetic*** **moment** of the electron, occurred in the calculations that we talked about in Part 1, has a different reason).

At a **circular motion**, in a moving coordinate system with unit **basis vectors**, **tangent** $\boldsymbol{\tau}$ and **normal** $\mathbf{n}$ (see picture below),

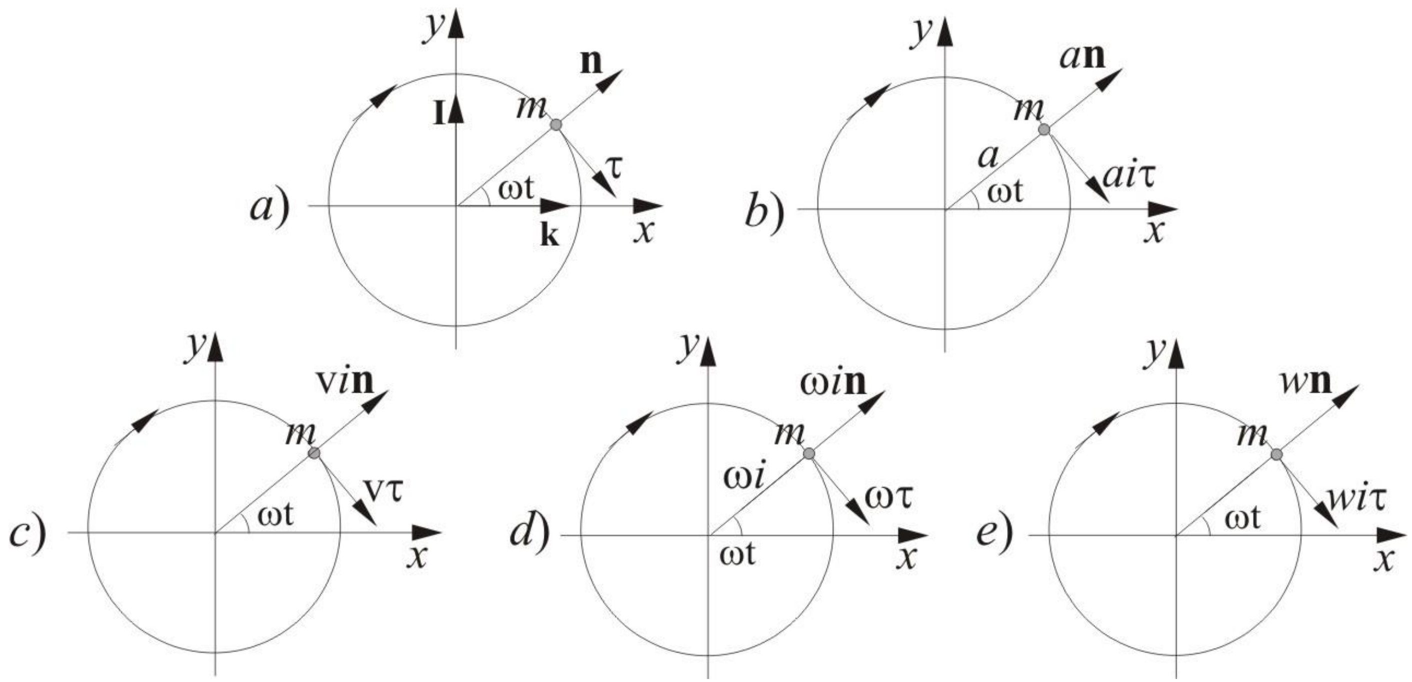
potential and **kinetic speeds**

are **related** by the **following way** (details are in [12]):

$$\hat{\mathbf{v}} = \hat{\mathbf{v}}_k + \hat{\mathbf{v}}_p = \upsilon\boldsymbol{\tau} + i\upsilon\mathbf{n} \qquad (2.23)$$

Scalar form of the **speed** (2.23) in the **mobile basis** is

$$\hat{\upsilon} = \upsilon_k + \upsilon_p = \upsilon + i\upsilon \qquad (2.24)$$



Kinematics of motion-rest along a circle [12]:

a) **units** vectors, $\boldsymbol{k}$ and $\boldsymbol{I}$ - in **motionless** basis, $\boldsymbol{\tau}$ and $\boldsymbol{n}$ - in **mobile** basis;

b) $\mathbf{r}_p = a\mathbf{n}$ and $\mathbf{r}_k = ia\boldsymbol{\tau}$ are potential and kinetic **radii-vectors** of motion;

c) $\mathbf{v}_p = i\omega a\mathbf{n} = i\upsilon\mathbf{n}$ and $\mathbf{v}_k = \omega a\boldsymbol{\tau} = \upsilon\boldsymbol{\tau}$ are potential and kinetic **velocities**;

d) $\boldsymbol{\omega}_p = i\omega\mathbf{n}$ and $\boldsymbol{\omega}_k = \omega\boldsymbol{\tau}$ are potential and kinetic **angular velocities**;

e) $\mathbf{w}_p = \omega^2\mathbf{r}_p = \omega^2 a\mathbf{n} = w\mathbf{n}$ and $\mathbf{w}_k = \omega^2\mathbf{r}_k = i\omega^2 a\boldsymbol{\tau} = iw\boldsymbol{\tau}$ are potential and kinetic **accelerations**.

And the **potential** and **kinetic** speeds are related as follows:

$$\upsilon_p = -i\upsilon_k \qquad (2.25)$$

Accordingly, an **operator** corresponding to the **potential speed** is equal to

$$\hat{\boldsymbol{p}}_p = -i\hat{\boldsymbol{p}}_k \qquad (2.26)$$

Taking into account the latter, that is, the **binary nature** of the **speed** and, consequently, **momentum** (2.26), the **operator** of **moment** of **momentum** $\hat{\boldsymbol{L}}$ takes the form,

$$\hat{\boldsymbol{L}} = \hat{\boldsymbol{L}}_k + \hat{\boldsymbol{L}}_p \qquad (2.27)$$

It **commutes** with the **Hamiltonian** (2.14) $\hat{H} = c\boldsymbol{\alpha}\hat{\mathbf{p}} + mc^2\beta$, that is,

$$\hat{\boldsymbol{H}}\hat{\boldsymbol{L}} - \hat{\boldsymbol{L}}\hat{\boldsymbol{H}} = 0 \qquad (2.28)$$

This means that **moment** of **momentum** $\boldsymbol{L} = \boldsymbol{L}_k + \boldsymbol{L}_p$ is an **integral** of **motion** and is **preserved**.

In other words, the **law of conservation of angular momentum** for such a moment is **respected**.

❋ ❋ ❋

Thus, the $\hat{\boldsymbol{L}}$ operator, which takes into account the binary nature of the parameters characterizing the circular motion, commutes with the total energy operator $\hat{\boldsymbol{H}}$ of the system.

Finally,

overcoming emerging issues by inventing new parameters,

what have physicists come to as a result?

As we see,

based on the concepts discussed above (in Parts 1 and 2),

the following ultimately happened:

Physicists have created quantum field theory -

Quantum Electrodynamics (QED)

Dirac equation became its **basic postulate.**

Dirac equation

is ***based on the Schrodinger equation (SE).***

The latter is a ***fictional equation*** – ***an abstract-mathematical postulate.***

And, as follows from our research,
its "solutions", to put it mildly, are erroneous, that is,
SE is inadequate to reality.

This has been convincingly proven
(**most** physicists probably already **know** this, see, for example, [13-17]).

Accordingly,

Dirac equation

is as well inadequate to reality.

Thus, **Dirac's equation** became **yet another** abstract-mathematical **creation** in a **chain** of **doubtful postulated concepts** accepted in physics, along with others discussed here.

Part 3

Unfortunate consequences

Thus, as we found out, the basis of QED,
including Dirac's equation, is highly doubtful, inadequate.

For this reason,
solving problems arising in physics
by Dirac's equation
is impossible without an elementary mathematical fitting.

First, the fitting **method** was applied in calculating the "**anomalous**" **magnetic moment** of the electron and the **Lamb shift**.

Since then, with increasing **accuracy** of the values obtained in this way for the "**anomaly**" and the **Lamb shift**, **using** the mythical **postulates**, for over 60 years, modern **quantum electrodynamics** (**QED**) has been **developed.**

The method of **fitting continues** to this day in connection with obtaining more **accurate** experimental **data**, and thanks to **advances** in computer technology, the advent of **supercomputers**.

In quantum theory of the atom

there is **no concept** of a **trajectory** (motion of electrons) or an **orbit**.

Therefore, in QED, the **calculation** of the perturbation value ("**anomaly**") is **performed** with respect to the **spin magnetic moment** of the electron (2.10).

However, as we have shown, the latter is a **fictitious parameter ascribed** to an electron **subjectively** (in addition to its **real** parameters, which are **mass** and **charge)**.

The **presence** of **spin magnetic moment** of the electron is **not confirmed experimentally**.

There is **no information** about experiments that have ever been conducted or planned to be carried out on **free electrons, not connected** with their atoms.

The results of the calculation of the «anomalous» magnetic moment of the electron

(in Quantum Electrodynamics, QED):

Adhering to the postulate about virtual particles, the derivation of the "anomaly" of the spin magnetic moment was carried out by the fit method and at the cost of enormous efforts for many decades by QED theorists from all over the world.

How deeply the theory of QED advanced, and to what **extent** of the perfection the **mathematical fitting** of the data to the experiment has achieved, one can **see** from the **extremely complicated** and **cumbersome** resultant formula (3.1) (see below) **derived for** the anomaly α_e (2.9) [18].

In fully expanded form the

QED calculation formula

for the **anomaly** α_e (2.9), entering in the expression $\mu_{e,spin} = -\mu_{\mathrm{B}}(1+\alpha_e)$ (2.10), is extremely **cumbersome** because of **huge** mathematical **expressions** for the **coefficients** in each of the terms of the formula.

Therefore, we placed here only a

Reduced expression for anomaly α_e,

represented in the form of an expansion in powers of

the fine-structure constant α,

with the numerical values of the coefficients already calculated (the data of 2003 [18]) :

$$\boxed{\begin{aligned}\alpha_e &= 0.5\left(\frac{\alpha}{\pi}\right) - 0.328478965579...\left(\frac{\alpha}{\pi}\right)^2 + 1.181241456...\left(\frac{\alpha}{\pi}\right)^3 - \\ &-1.5098(384)\left(\frac{\alpha}{\pi}\right)^4 + 4.382(19)\times 10^{-12} = 0.0011596521535(12)\end{aligned}} \quad (3.1)$$

The alpha constant (α)

(entering into (3.1))

is the **fundamental constant** of modern physics, called the **fine-structure constant** :

$$\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c}$$

$\alpha = 7.2973525664 \times 10^{-3}$ (see [2014 CODATA recommended values])

The **nature** of its **origin** still **is** the greatest **mystery** for modern physics. Most till now do not know that this problem has already been solved in the framework of WM (details in [19]).

<u>For those who will be interested in this</u>:

According to the Wave Model,

α–constant is a dimensionless physical **quantity** that shows the **scale correlation** of **<u>threshold</u> conjugate** parameters, **oscillatory** and **wave**, inherent in the wave motion. For example, it characterises the ratio of speeds:

$$\alpha = \upsilon_0 / c,$$

υ_0 – **maximal oscillatory** speed of the **electron** in a hydrogen atom (the speed in the **first Bohr** orbit), and c – the **maximal base** speed of **propagation** of **waves generated** by the pulsating wave shell of the proton (the **wave speed**) [20].

About numerical coefficients in Eq. (3.1)

An **example.** The **coefficient** at the **fourth term** of the expansion in (3.1), $(\alpha/\pi)^4$, is equal to $1.5098(384)$.

It was received with **great uncertainty** in the last three signs, ± 384 , and is the **result** of computing **more than** 100 **huge ten-dimensional integrals**!

The **last** small **term** in formula (3.1), $4.382(19)\times 10^{-12}$, takes into account the **contribution** of quantum **chromodynamics**.

Therefore, earlier, for calculations, a **complex system** of **massively-parallel** computers of **giant performance** was **used** (now - supercomputers).

In fact, we are **witnessing** the continuing **grandiose mathematical fitting**, which **reached** the highest degree of **perfection** during about 70 **years** that passed after the first works of 1947 by H. A. Bethe [21] and T. A. Welton [22], **thanks** to the **strenuous efforts** of physicists-theorists from **all over the world**.

Thus, the QED **formula** for the "**anomaly**" (3.1), posted here with the coefficients already calculated for the terms of the expansion, was **derived** with **allowance** for the **influence** of **virtual** (mythical) **particles**.

In fully expanded form with coefficients, it is **extremely cumbersome**. Expressions for the **coefficients** represent complex **ten-dimensional integrals** (!), for the calculation of which (there are **hundreds** of **them**) supercomputers are required.

The **numerical value** of the "**anomaly**" calculated by the formula (3.1) [17] is equal to

$$a_e = 1.1596521535(12) \cdot 10^{-3} \qquad (3.2)$$

Up to the 7th decimal place **this value** of the "anomaly" (3.2) **coincides** with the last value **recommended** for **use** in physics in 2016 [23].

The accepted **values** of all main **parameters** considering here, including (3.2), are given below:

The values of parameters related with the spin concept

recommended for **use** in physics in 2016 (CODATA [23])

1. ***Bohr magneton*** $\mu_B = 927.4009994 \cdot 10^{-26}\, J \cdot T^{-1}$ (3.3)
2. ***spin magnetic moment of an electron*** $\mu_{e,spin} = -928.4764620 \cdot 10^{-26}\, J \cdot T^{-1}$ (3.4)
   $\mu_{e,spin} = -\mu_{\mathrm{B}}(1+\alpha_e)$
3. ***«Anomaly» of the moment*** $a_e = 1.15965218091 \cdot 10^{-3}$ (3.5)
4. ***Electron g-factor*** $g_e = 2.00231930436182$ (3.6)
   $g_e = 2(1+\alpha_e)$

1. The ***<u>Bohr magneton</u>*** μ_B is defined in atomic physics as "*a **physical constant** and the natural **unit** for expressing the magnetic moment of an electron caused by either its orbital or spin angular momentum*".

In magnitude, μ_B was taken **equal** to the erroneously calculated value of the **orbital** magnetic moment $\mu_{orb,th}$: $\mu_B = |\, \mu_{orb,th} |$.

2. The value of $\mu_{orb,th}$ was also subjectively ascribed to the **<u>spin magnetic moment</u>** of an electron $\mu_{e,spin}$. Thus, **<u>initially</u>**, $\mu_{e,spin} = \mu_{orb,th} = -\mu_B$.

Later, after the subsequent **correction** of $\mu_{e,spin}$ (taking into account the "**anomaly**" α_e), the **updated** value (3.4) became a little **bigger** in magnitude compared to the **originally** accepted value (3.3). So **<u>now</u>**, $\mu_{e,spin} = -\mu_B (1+\alpha_e)$.

3. <u>On the value of "anomaly"</u> α_e (3.5).

Spin **magnetic moment** $\mu_{e,spin}$ of the **accepted value** (3.4)

has not been confirmed experimentally, directly on free electrons not bound to atoms.

Its numerical **value** was determined by **subtraction** of $\mu_B = |\mu_{orb,th}|$ from $\mu_{orb,\exp}^{updated}$:

$$\mu_{orb,\exp}^{updated} - \mu_{\mathrm{B}} = \mu_{e,spin} \qquad (3.7)$$

Further, knowing the magnitude of $\mu_{e,spin}$, from the relation

$$\alpha_e = \frac{|\mu_{e,spin}|}{\mu_{\mathrm{B}}} - 1 \qquad (3.8)$$

(see Eq. (2.10)), the experimental value of the **anomaly** α_e was **determined**.

Then, to **get** the appropriate theoretical **formula** for the **anomaly** α_e, which should **correspond** with **high accuracy** to the experimental **value** α_e **obtained** from the **above relation** (3.8), the sophisticated theoretical **manipulations** (fitting) have **began**.

As a result, despite the **great difficulties**, thanks to the **enormous effort**, the above **formula** (3.1) for **anomaly** α_e was **ultimately devised**.

As we have shown,

spin magnetic moment, $\mu_{e,spin}$ **,**

attributed to an electron, of the value (3.4),

is **erroneously** associated with a fictional **internal property** of a **free electron.**

This quantity is actually that **half** of the μ_{orb} that was **lost** at the calculations.

Thus, in magnitude,

the orbital magnetic moment of the electron

(in the Bohr orbit)

is equal to the **sum** of the **two** above **moments** (approximately **equal** in value), (3.3) and (3.4), **recommended** for use **in physics**; that is, $\mu_{orb} = \mu_{orb,th} + \mu_{e,spin}$, where

$$\mu_{orb,th} = -\mu_B = -927.4009994 \cdot 10^{-26}\ J \cdot T^{-1}$$

$$\mu_{e,spin} = \mu_{orb,th}(1+\alpha_e) = -928.4764620 \cdot 10^{-26}\ J \cdot T^{-1}$$

The **influence** of the electron's **own motion** (own rotation and oscillations) on the magnitude of its **orbital moment** is insignificant, $\alpha_e \approx 0.00116$ (3.5).

So, as we found out,

$\mu_{orb,th}$ and $\mu_{e,spin}$

are two half of the <u>orbital magnetic moment</u> of an electron.

Their **sum** is exactly **equal**
to the **experimentally** obtained **value** of this moment.

This discovery can be expressed by the equality:

$$\boxed{\begin{aligned}\mu_{orb} &= \mu_{orb,th} + \mu_{orb,th}(1+\alpha_e) = \mu_{orb,th}(2+\alpha_e) = \\ &= \mu_{orb,\exp}^{updated} = -1855.8774614 \cdot 10^{-26}\ J \cdot T^{-1}\end{aligned}} \qquad (3.9)$$

The **first** term in (3.9) is the **erroneously calculated <u>orbital</u>** magnetic moment of the electron (**twice less** than experimentally obtained). Its absolute value was a**ccepted** in physics as a fundamental physical constant under the name the **Bohr magneton**, $\mu_B = |\mu_{orb,th}|$ (3.3).

The **second** term represents the "**lost**" part of the **<u>orbital</u>** magnetic moment of the electron (with allowance for the "**anomaly**" α_e), **attributed erroneously** to a **free electron** as its internal parameter called **spin magnetic moment,** $\mu_{e,spin}$ (3.4).

Recall

the **development** of the **GED theory**
began with an

erroneous solution

for the

electron orbital magnetic moment

in a hydrogen atom.

The correct solution for μ_{orb},

to which we have come thanks to the Wave Model,

is given below in Part 4

Part 4

Solutions
of the
Wave Model
for the orbital magnetic moment of an electron

Solutions of the Wave Model

(where the concept of circular orbits is inherent in the structure of atoms)

directly lead to the true value (3.9) **of the orbital magnetic moment** μ_{orb} **.**

The Wave Model

(which we have developed)

is based on dialectics (dialectical philosophy and its logic).

In accordance with the latter the **Universe** is the **material-ideal system**, where **everything** at all its levels, including micro and mega, is in a **continuous oscillatory-wave** motion and is **subject** to the law of **rhythm.**

This means that

all objects and phenomena in the Universe have a wave nature, accordingly, the general wave equation

$$\boxed{\Delta\hat{\Psi} - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}}{\partial t^2} = 0} \qquad (4.1)$$

is applicable to describe them.

The above feature

is **accepted** in the Wave Model (WM) as an

axiom

and is taken into account in the description of physical phenomena, including the "**anomalous**" **magnetic moment** of an electron.

Judging by the results, WM can be considered as a real replacement for the Standard Model of modern physics.

There is a series of **publications** devoted to the **WM**. Their list can be found on the **website** of the author, http://shpenkov.com, and they are available for download.

Details concerning conceptions of the **WM** and the **unique results** obtained within its two theories were **presented**, in particular in **2017**, at two **International Conferences** on:

Quantum Physics and **Quantum Technology** (**Berlin**, Germany) [24], and **Physics** (**Brussels**, Belgium) [25].

In [24, 25], there are links to **videos** and **pdf-files** of the above presentations.

In the Wave Model,

there are no postulated (fictional) concepts,

such as the electron "spin", and so on.

The so-called "anomaly" is explained in WM

as the effect of intra-atomic wave processes on the orbital motion of the electron.

But in any case this is **not due** to the influence of **mystical virtual** photons on the **mystical spin** of an electron.

So, according to the WM,

insignificant perturbation (“anomaly”) of the electron orbital motion in an atom is due to the wave nature and wave behaviour of the constituent particles of the atom and of the atom as a whole

(which is an interconnected nucleon-electron wave system).

In the framework of the Wave Model,

the formula of the **orbital magnetic moment**, taking into account weak perturbations ("anomaly"), is derived relatively **simply** and logically **flawlessly** [8, 26].

Here is its **completely expanded** form:

$$\boxed{\mu_{orb,WM} = -\frac{e\upsilon_0}{c}\left[r_0 + \left(\lambda\!\!\!^{-}_e + \frac{r_0}{b'_{0,1}}\right)\sqrt{\frac{4\pi R\hbar}{m_0 c}} + r_0 \frac{2\beta}{(y_{0,1}+y'_{0,1})}\sqrt{\frac{4\pi R\hbar_e}{m_e c}}\right]} \;! \qquad (4.2)$$

The **orbital magnetic moment** of an electron, obtained **directly** from this equation, is

$$\boxed{\mu_{orb,WM} = -1855.877614\cdot 10^{-26}\ J\cdot T^{-1}} \;! \qquad (4.3)$$

It completely coincides in magnitude with $\mu_{orb,\exp}^{updated}$
and the total magnetic moment of the orbiting electron (3.9),

when **summing** the two moments, μ_B (3.3) and $\mu_{e,spin}$ (3.4), which despite the fact that in modern physics **characterize**, by definition, **other properties**, nevertheless (for the reasons stated above), **are two parts** of **one parameter** characterizing the **orbital motion** of an electron. Really, $\mu_{orb,\exp}^{updated} = \mu_{orb,th} + \mu_{orb,th}(1+\alpha_e)$, where

$$|\mu_{orb,th}| = \mu_B \quad \text{and} \quad \mu_{orb,th}(1+\alpha_e) = \mu_{e,spin}$$

Physical parameters,

components of equation (4.2):

$b'_{0,1}$, $y_{0,1}$, $y'_{0,1}$ – **Roots** of **Bessel** functions (**radial solutions** of wave equation).

R – **Rydberg** constant; r_0 and υ_0 – **Bohr** radius and speed, respectively.

r_e – **Radius** of the wave spherical **shell** of an electron, $r_e = 4.17052597 \cdot 10^{-10}\, cm$.

ω_e – **Fundamental frequency** of atomic and subatomic levels,
$\omega_e = 1.869162469 \cdot 10^{18}\, s^{-1}$.

$\hbar_e$ – **Own moment** of momentum of an electron, $\hbar_e = (2/5) m_e \upsilon_e r_e$, ($\upsilon_e = \upsilon_0 (r_e / r_0)$) .

e – **Elementary quantum** of the **rate** of mass exchange ("**electron** "**charge**"),
$e = m_e \omega_e = 1.702691665 \cdot 10^{-9}\, g \cdot s^{-1}$.

m_0 and m_e – **Associated masses** of the proton and electron, respectively.

c – **Basis speed** of the **wave exchange** at the atomic and subatomic levels,
(speed of light is equal to this value).

$\lambda\!\!\!^{-}_e = c / \omega_e$ – **Fundamental wave radius**, $\lambda\!\!\!^{-}_e = 1.603886998 \times 10^{-8}\, cm$.

Note

Parameters: $r_e\ ,\ \omega_e\ ,\ \hbar_e\ ,\ \lambdabar_e$ –

fundamental physical constants **following** from the **Wave Model**,

previously unknown to modern physics.

Parameters: $e,\ m_0\ ,\ c$ –

fundamental physical constants of **modern** physics, whose **true physical meaning** was **clarified** thanks to the **WM.**

❋ ❋ ❋

It should be emphasized once again that

for the electron charge e

both its true **value** and **dimensionality** were discovered:

$$e = 1.702691665 \cdot 10^{-9}\ g \cdot s^{-1}$$

This means that at last we knew the nature of electric charges.

The first term

in (4.2), $-\frac{\upsilon_0}{c}er_0$, corresponds to the **orbital magnetic moment calculated** by the equation (1.21) (where the true value of the average current $I = 2e/T_{orb}$ is used):

$$\mu_{orb} = \frac{1}{c}\left(\frac{2e}{T_{orb}}\right)S$$

It is equal in **value** to the orbital magnetic moment of the electron $\mu_{orb,\exp}$ initially **obtained** (1.3) in the Einstein-de Haas **experiments**,

$$-\frac{\upsilon_0}{c}er_0 = -\frac{e\hbar}{m_e c} = \mu_{orb,\exp} \qquad (4.4)$$

In **absolute** value, $\mu_{orb,\exp}$ is equal to the **doubled** value of the **Bohr magneton** (and also the **doubled** value of the **spin magnetic** moment **without** taking into account the correction, «**anomaly**», determined later):

$$\mu_{orb,\exp} = 2\mu_B = 2\mu_{e,spin} = \frac{e\hbar}{m_e c} \qquad (4.5)$$

The **next terms** in Eq. (4.2) **take into account** the subsequent ***correction*** –

«anomaly»:

Namely, the **second** term determines the **contribution** (in the orbital magnetic moment of the electron) of the **disturbance caused** by ***vibration of the center of mass*** of the hydrogen atom, ***as a whole***, in the wave ***spherical field*** of exchange, **limited** by the ***wave radius*** $ƛ_e$ (the **oscillatory region** of the atom),

$$\delta\mu_{orb,1} = -\frac{e\upsilon_0}{c} ƛ_e \sqrt{\frac{2Rh}{m_0 c}} \qquad (4.6)$$

The wave motion **causes** ***oscillations of the wave spherical shell*** of the hydrogen atom, **limited** by the **Bohr radius** r_0, **together** ***with the electron*** moving along the orbit.

The **third** term in (4.2)) takes these oscillations into account :

$$\delta\mu_{orb,2} = -\frac{e\upsilon_0}{c} \frac{r_0}{b'_{0,1}} \sqrt{\frac{2Rh}{m_0 c}} \qquad (4.7)$$

where $z_{0,s} = b'_{0,1} = 2.79838605$ is the first root of the spherical Bessel functions of the zero order.

According to the **Dynamic Model** of elementary particles (which is one of the two theories of the WM), an **electron**, like a proton (or like **any** elementary particle), is a **dynamic spherical** formation.

Therefore, the own ***vibrations of the centre of mass of the electron*****,** caused by different reasons, also take place.

The **fourth** term **takes into account** the contribution of these vibrations,

$$\delta\mu_{orb,3} = -\frac{e\upsilon_0 r_0}{c}\left(\frac{2\beta}{(y_{0,1}+y'_{0,1})}\sqrt{\frac{4\pi R\hbar_e}{m_e c}}\right) \qquad (4.8)$$

This term, including the parameter $\hbar_e = (2/5)m_e\upsilon_e r_e$ (where r_e is the **radius** of the wave spherical **shell** of an electron), obviously, is related to the **own motion** of the electron and, hence, corresponds to its ***own (spin) magnetic moment***.

As follows from the Wave Model, $r_e = 4.17052597\cdot 10^{-10}\ cm$.

Small empirical **coefficient** $\beta = 1.022858$ compensates for some **uncertainty** of the **radial solution** (roots of Bessel functions) and the **linear speed** υ_e of rotation of an electron around its **own axis** (at the equator of its wave spherical shell of radius r_e) defined by the relation $\upsilon_e = \upsilon_0 (r_e / r_0)$, where υ_0 and r_0 are, respectively, the Bohr speed and radius.

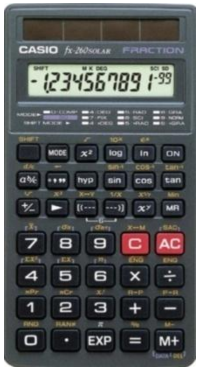
The contribution of $\delta\mu_{orb,3}$ to the total magnetic moment of the orbiting electron (4.3) is **insignificant**

$$\mu_{e,spin} = \delta\mu_{orb,3} = 5.609964 \cdot 10^{-29} \; J \cdot T^{-1} \qquad (4.9)$$

and is **0.0003%,** compared with an **incredible** **50%** **contribution** to the total magnetic moment of the ***spin magnetic moment***, $\mu_{e,spin} = -9.284764620 \cdot 10^{-24} \; J \cdot T^{-1}$, assigned erroneously to the electron.

Intra-atomic oscillatory-wave processes, **taken into account** in Eq.(4.2), **perturb** (modulate) the **orbital motion** of the **electron**, which **manifests** itself, in particular, in the **phenomenon** of the "**anomalous**" magnetic moment of the electron and in the phenomenon called the **Lamb shift**.

In **equation** derived in the framework of the WM (4.2), there are **no integrals**. The **orbital magnetic moment** of an electron (taking into account the “anomaly”) is **easily** to **compute** with help of a **calculator**.



Since $-\frac{\upsilon_0}{c} e r_0 = -\frac{e\hbar}{m_e c}$, **equation** (4.2) can be presented (similar to equation (2.10) of QED for $\mu_{e,spin}$) as

$$\boxed{\mu_{orb,WM} = -\frac{e}{m_e c}\hbar(1+\alpha_{e,WM})} \qquad (4.10)$$

where $\alpha_{e,WM}$ is the “**anomaly**” related to the **orbital motion** of an electron.

From Eq. (4.2) for $\mu_{orb,WM}$, it **follows** that the **explicit** (complete) form of the **expression** for $\alpha_{e,WM}$ is:

$$\boxed{\alpha_{e,WM} = \frac{1}{r_0}\left(\bar{\lambda}_e + \frac{r_0}{b'_{0,1}}\right)\sqrt{\frac{4\pi R\hbar}{m_0 c}} + \frac{2\beta}{(y_{0,1}+y'_{0,1})}\sqrt{\frac{4\pi R\hbar_e}{m_0 c}}} \qquad (4.11)$$

The indisputable **advantage** of this expression, obtained within the **WM**, is clearly seen when **comparing** it with an **incredibly cumbersome** formula for α_e (3.1) following from QED.

Thus, a **formula connecting** the **orbital magnetic moment** of an electron with the notions of g-**factor** and "**anomaly**" has, in the WM, the following form:

$$\boxed{\mu_{e,WM} = -g_{e,WM}\frac{e}{m_e c}\hbar = -2\mu_B(1+\alpha_{e,WM})} \qquad (4.12)$$

In the WM, the **anomaly** $\alpha_{e,WM}$ and $g_{e,WM}$-factor are parameters that **characterize** the behaviour of a **bound electron**. That is, they relate to its **orbital motion**, but not to the motion of a free electron unbound to an atom (as it is accepted to consider the g_e and α_e parameters in QED).

The g-**factor** for the **orbiting** electron is equal to

$$\boxed{g_{e,WM} = (1+\alpha_{e,WM})} \qquad (4.13)$$

Since

$$g_{e,WM} = \left|\mu_{e,\exp}\right| / 2\mu_B = 1.000579826 \qquad (4.14)$$

the "**anomaly**" is:

$$\boxed{\alpha_{e,WM} = g_{e,WM} - 1 = 5.79826\cdot 10^{-4}} \qquad (4.15)$$

It makes sense to **emphasize** once again that the **anomaly** α_e and the g_e-**factor** are parameters attributed in modern physics to a **free electron**. This is a **consequence** of the **subjective assignment** to the electron of the **concept** of **spin** of relatively **enormous value** of $\hbar/2$, which is an **inadequate** reality.

Thus, the ratio
of the magnetic moment to the moment of momentum

of the **orbiting** electron,

$$\boxed{\frac{\mu_e}{\hbar} = \frac{e}{m_e c}} \qquad (4.16)$$

corresponds to Einstein's-de Haas's experiment.

As was **discovered** in the WM, the **electron charge** e is the **elementary quantum** of the **rate of mass exchange**. It is equal to the product of its **associated mass** m_e and the **fundamental frequency** $\omega_e = 1.869162559 \times 10^{18}\, s^{-1}$ of the **atomic** and **subatomic** levels:

$$\boxed{e = m_e \omega_e} \qquad (4.17)$$

Substituting (4.17) into (4.16), we arrive at the following result:

$$\boxed{\frac{\mu_e}{\hbar} = \frac{e}{m_e c} = \frac{\omega_e}{c} = \frac{1}{\lambda\!\!\!^{-}_e} = k_e} \qquad (4.18)$$

The data obtained mean that the ***ratio of the moments*** (4.16) ***is of fundamental importance***. It is equal in magnitude to the **fundamental wave number** k_e, related with the **fundamental frequency** ω_e and the **fundamental wave radius** $\lambda\!\!\!^{-}_e$ [25, 26].

The above data are in accordance with the **objective theory** of **electromagnetic processes** (described in the WM) [4]. Relations (4.18) are also **valid** for **proper** moments.

Comparison

of

WM *and* QED

solutions

Approaching the end, it should be recalled that

Orbital magnetic moment of an electron

following directly from the **Wave Model** (formula (4.2))

$$\boxed{\mu_{orb,WM} = -1855.877461 \cdot 10^{-26}\ J \cdot T^{-1}} \qquad (4.3)$$

The contribution of the spin magnetic moment in (4.3) is **insignificant:**

$$\mu_{e,spin,WM} = 5.609964 \cdot 10^{-29}\ J \cdot T^{-1}$$

The value presented above (4.3) **coincides**

with the value of the **orbital magnetic moment, following** from

Quantum Electrodynamics (QED),

when **summing** the two components of the moment, (3.3) and (3.4), roughly equal in value, that is:

$$\boxed{\mu_{orb,QED} = \mu_{e,spin} + (-\mu_B) = -1855.8774614 \cdot 10^{-26}\ J \cdot T^{-1}} \qquad (3.9)$$

where $\mu_{e,spin}$ is actually that **half** of the μ_{orb}, which was **lost** at the calculations, with allowance for "anomaly" $\mu_{e,spin} = \mu_{orb,th}(1+\alpha_e)$, and $-\mu_B = \mu_{orb,th}$.

Comparison of the effectiveness of two theories:
Quantum Electrodynamics (QED) and the Wave Model (WM)

(by comparing the formulas of the “anomaly” following from these theories)

Reduced form **QED**

$$\alpha_e = 0.5\left(\frac{\alpha}{\pi}\right) - 0.328478965579...\left(\frac{\alpha}{\pi}\right)^2 + 1.181241456...\left(\frac{\alpha}{\pi}\right)^3 - $$
$$-1.5098(384)\left(\frac{\alpha}{\pi}\right)^4 + 4.382(19)\times 10^{-12} = 0.0011596521535(12) \qquad (3.1)$$

Numerical factors were computed on **supercomputers**.

$\alpha = e^2 / (4\pi\varepsilon_0 \hbar c)$ is the **fine-structure** constant.

All pages of this slide presentation are not enough if we would wanted to place formula (3.1) with the explicit form of all integral expressions for the coefficients in the terms of the expansion.

Full, explicit form **WM**

$$\alpha_{e,WM} = \frac{1}{r_0}\left(\lambda\!\!\!^{-}_e + \frac{r_0}{b'_{0,1}}\right)\sqrt{\frac{4\pi R\hbar}{m_0 c}} + \frac{2\beta}{(y_{0,1} + y'_{0,1})}\sqrt{\frac{4\pi R\hbar_e}{m_0 c}} \qquad (4.11)$$

To calculate it is **enough** a simple **calculator**.

$b'_{0,1},\ y_{0,1},\ y'_{0,1}$ – roots of Bessel functions.

Parameters of an electron,

orbital and own ("spin"):

Accepted in modern physics (QED)	*According to the* Wave Model (WM)

Experimental value

$$\mu_{orb,\exp} = -1855.8774614 \cdot 10^{-26}\ J \cdot T^{-1}$$

Parameters	QED	WM
	erroneous	correct
μ_{orb} theoretical	$\mu_{orb,QED} = -927.4009994 \cdot 10^{-26}$	$\mu_{orb,WM} = -1855.877461 \cdot 10^{-26}$
μ_{spin}	$\mu_{spin,QED} = -928.4764620 \cdot 10^{-26}$ subjectively introduced, erroneous, unreal	$\mu_{spin,WM} = -5.609964 \cdot 10^{-29}$
μ_{spin} / μ_{orb}	1.001159652 erroneous, unreal	0.000003 correct
α_e anomaly	$a_{e,spin,QED} = 1.15965218091 \cdot 10^{-3}$ $\frac{\mu_{spin,QED}}{\mu_B} - 1$ $\frac{\alpha_{e,spin,WM}}{\alpha_{e,spin,QED}} = 2.560 \cdot 10^{-3}$	$\alpha_{e,orb,WM} = 5.79826 \cdot 10^{-4}$ $\frac{\mu_{orb,WM}}{2\mu_B} - 1$ $\alpha_{e,spin,WM} = 3.024562192 \cdot 10^{-6}$ $\frac{\mu_{spin,WM}}{2\mu_B}$
g_e-factor	$g_{e,QED} = 2.00231930436182$ $2(1+\alpha_{e,spin,QED})$	$g_{e,WM} = 1.000579826$ $(1+\alpha_{e,orb,WM})$

Conclusion

I

A **gross error** in physics was **revealed**.

As **we found out**, this error **happened** when **calculating** the orbital magnetic moment of an electron in an atom by the formula

$$\mu_{orb} = (I / c)S \ ,$$

where the **mean value** of the **circular current** I, created by a **discrete charge** moving along an **orbit**, was taken in the form

$$I = e / T_{orb} \ ,$$

as indicated in all sources, including fundamental **university textbooks** on physics.

As it turned out, this **formula** for current I is **erroneous**.

The **cause** of the **error** was **identified**.

The **true** average **value** of the circular current turned out to be **two times larger**, that is,

$$\boxed{I = 2e / T_{orb}}$$

that has been convincingly **proven**.

II

The **arguments** given in this report are **convincing** enough to claim that the **electron spin** of $\hbar/2$ was **erroneously** introduced in physics.

Accordingly, the **spin magnetic moment** of an electron, corresponding to the spin,

$$\mu_{e,spin} = -\frac{1}{2}\frac{e\hbar}{m_e c}$$

is **erroneous** as well.

The own moment of momentum (spin) of an enormous value of $\hbar/2$ was **formally** (arbitrarily, subjectively) **attributed** to a **free** electron to **compensate** for the **error** in two times made by physicists-theorists when calculating μ_{orb} .

In modern physics, it is **generally accepted** that, given the anomaly α_e ,

$$\mu_{e,spin} = -\frac{1}{2}\frac{e\hbar}{m_e c}(1+\alpha_e) = -928.4764620 \cdot 10^{-26}\ J \cdot T^{-1}$$

This parameter, attributed to the electron as some kind of intrinsic (quantum, non-mechanical) property, has **nothing in common** (just as the **electron spin** of $\hbar/2$) with the **real parameters** actually **inherent** in the electron, like its mass and charge.

There are no experimental evidence
to support the existence of the above parameters, characteristic,
as believe, for *free electrons* (unbound with atoms)!

III

By **definition** **accepted in physics**, ***the gyromagnetic ratio*** γ ***of a particle or system is the ratio of their magnetic moment to angular momentum***, and it has the form,

$$\gamma = \frac{q}{2mc}$$

For an **electron,**

$$\gamma_e = \frac{\mu_e}{\hbar} = \frac{e}{2m_e c}$$

Both above equalities are **erroneous**, twice less than real (the presence of the number 2 in the denominators appeared due to an **error** in the calculations).

The correct expressions for the **gyromagnetic ratios,** γ and γ_e (**according to the Wave Model**), are as follows:

$$\boxed{\gamma = \frac{q}{mc}} \quad \text{and} \quad \boxed{\gamma_e = \frac{\mu_e}{\hbar} = \frac{e}{m_e c}}$$

These expressions are valid for both orbital and own moments.

The **gyromagnetic ratio** $\gamma = q/mc$ is of **fundamental importance**.

For the **electron**, the gyromagnetic γ_e ratio is related with the fundamental physical constants (**discovered** in the WM): **fundamental frequency** ω_e of the atomic and subatomic levels, **fundamental wave radius** $\lambda\!\!\!^{-}_e$, and the **fundamental wave number** k_e :

$$\boxed{\gamma_e = \frac{\omega_e}{c} = \frac{1}{\lambda\!\!\!^{-}_e} = k_e}$$

IV

The **hypothesis** of **virtual photons**, which an electron **allegedly** **emits** and **absorbs**, and which, as **believe**, **lead** to a **change** in the **effective mass** of the **electron**, resulted in the **appearance** of **anomalous magnetic moment** in it, is also **erroneous**.

Therefore, the **direct derivation** of the "anomaly", based on the mystical influence of the hypothetic (**virtual**) particles, naturally, **proved to be an insoluble problem**.

For this reason, QED is actually engaged in **skill mathematical manipulations**, uses the **method** of sophisticated **fitting** that requires the use of **supercomputers**.

The **highest** degree of "**perfection**" was **achieved** in this case that clearly seen from the **very complex** and **cumbersome** resulting formula for **anomaly** α_e. Therefore, we were able to place and shown in this report only its **abbreviated form** (3.1).

V

Within the Wave Model,

the **orbital magnetic moment** of the electron (μ_{orb}) is **derived** in a natural way and **logically flawlessly,** that is clearly seen from the simple (complete, explicit) **formula** (4.2), in which the "**anomaly**" (α_e) is directly **taken** into account.

The **value** of the **orbital magnetic moment** of the electron (4.3)

$$\boxed{\mu_{orb,WM} = -1855.877461 \cdot 10^{-26}\ J \cdot T^{-1}}$$

obtained in the WM from Eq. (4.2) (note once more, without using the **postulate** on virtual particles) completely **coincides** with the last known **experimental** value (3.9).

For **calculations** it is enough to have a simple household **calculator**.

Thus, "electron spin“ is a fictional parameter.

It has **nothing to do** with a **mechanical rotation** of an electron around its own axis, which only could cause the own **magnetic moment**.

By definition accepted in **quantum physics**, electron spin is a some kind of **quantum parameter** (intrinsic, non-mechanical) of the electron.

Accordingly, in principle, it cannot cause a **magnetic moment,** which is the result of **mechanical** motion.

Therefore,
the detection of non-existent
intrinsic magnetic moments of free electrons

directly on free electrons

has not been carried out and is not undertaking in physics.

Obviously, physicists understand
the senselessness of trying to find something
that does not exist in reality.

Taking into account all the data, including presented here, **quantum electrodynamics** (dominant theory of modern physics) can be **compared** figuratively, **by analogy**, with the **Tower** of **Babel**, moreover, with its worst option, since it is **building** on a **ghostly foundation** – **fictional** subjectively introduced abstract-mathematical **postulates**.

This means that at present, **modern physics** is on the wrong track.

It is very important to remind that the whole chain of questionable concepts, associated with the creation of QED,

began with the use of an erroneous formula for the average current $I = e / T_{orb}$ **generated by the orbiting electron!**

Surprisingly,
so far almost for a **century, no one paid attention to this formula (!), mentioned in almost all relevant physics textbooks,**
which led to a serious consequences for physics.

Afterword

One mistake – HUGE CONSEQUENCIES!

Erroneous concepts (abstract-mathematical postulates) are in the **base** of the **modern physical theories** adhering the **Standard Model**. They in turn have **given rise** to numerous **subjective** ("fundamental") constants.

All this **complicates cognition** of the Universe, ***or even makes it impossible***, in particular, at the **atomic** level.

Experiments based on the erroneous concepts are **unable to detect** the **accumulated errors**. Thus, everything is ***formally*** "**right**" and "**consistent**".

Wrong concepts give rise to **false theories**, within which ***formally correct results*** are possible only on the **basis** of **new errors** – in full agreement with the **dialectical law** of **double negation**:

$$No_1 \cdot No_2 = Yes$$

where $\boldsymbol{No_1}$ is the **initial lie**, $\boldsymbol{No_2}$ is a **new lie**, and $\boldsymbol{Yes}$ is the **formal truth**.

The **result** of this course of events can be only one – a **dead end**.

However, as we see,

not everything is so hopeless.

Judging by the obtained results,

Wave Model,

based on the new paradigm,

can really replace the Standard Model,

dominant in modern physics, and

change the unfavourable trend

characteristic of the modern development of physics.

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