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Keynote Speech
on

TROUBLE
with the
ELECTRON SPIN

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Preface

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 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 **research** has **shown**, however, that it was made a **fundamental mistake** in accepting **the spin concept**, as if it were real, allegedly characterizing free particles.

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

> deal **not** with the **own mechanical** moments (called the **spin**) of **free electrons**, as they believe, and their **own magnetic** moments corresponding to the spin,
>
> but with the **orbital** mechanical and **orbital** magnetic moments of **electrons bound** to **atoms**, $i.\ e.$, with **magnetic** moments of **atoms**.

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

Part 1

FUNDAMENTAL MISTAKES

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!

Running ahead, I will say that

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

Accordingly, the **calculated** ***orbital magnetic moment*** of an 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 **concept** of own mechanical moment of a relatively **huge** absolute **value** of $\hbar/2$ (**spin**) and corresponding to it the own (**spin**) **magnetic moment, just equal to the lost half,** were ***subjectively introduced*** eventually.

!

The ***opinion*** has fully **formed** that the **presence** of an **intrinsic** mechanical moment of an electron (spin) of magnitude $\hbar/2$ 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 to atoms) is absent.

I will try to explain **where** and **why** an inexcusable mistake (fateful for the development of physics) was made**,** which led to **introducing** in physics (**unreasonably,** as we revealed) the above-mentioned ***inadequate notions*** with the following **values attributed** to them:

$$\frac{1}{2}\hbar \quad - \text{ to } \textbf{\textit{electron spin}},$$

and

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

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.

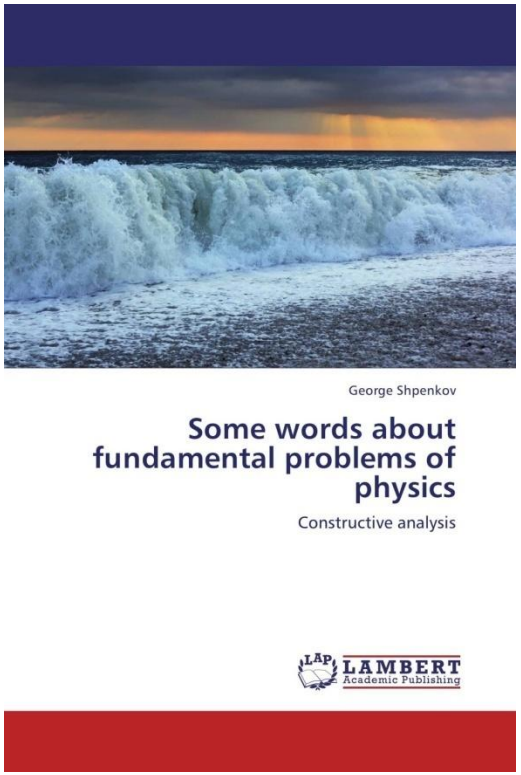
Planck’s constant divided by 2π ,

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

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**:

$$\hbar = m_e \upsilon_0 r_0 \qquad (1)$$

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) and the formula for h,

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

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** v_n of the electron is the **constant** value, $v_n r_n = const$. 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 related with the **rotational momentum** $\hbar$ (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].

Very briefly

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

$$\frac{\mu_{orb,\exp}}{\hbar} = -\frac{e}{m_e c} \qquad (3)$$

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

$$\frac{\mu_{orb,th}}{\hbar} = -\frac{e}{2m_e c} \qquad (4)$$

(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 (4)), instead of looking for a mistake 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 mechanical 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 magnetic 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 (4) with (3)!) **spin magnetic moment, corresponding** to the electron **spin** of the value $\hbar/2$,

$$\mu_{e,spin} = -\frac{e\hbar}{2m_e c}, \qquad (5)$$

was ***subjectively attributed*** to the electron.

In this way, the "**lost half**" of μ_{orb} in the theoretically obtained ratio (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 :

$$\mu_B \equiv \left|\mu_{e,spin}\right| = \left|\mu_{orb,th}\right| = \frac{e\hbar}{2m_e c} \qquad (5a)$$

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 magnetic moment in Eq. (4).

As a result **they** have **come** to the **desired gyromagnetic ratio**, coinciding with the ratio (3) obtained from the experiment:

$$\frac{\mu_{orb}}{\hbar} = \frac{\mu_{orb,th} + \mu_{e,spin}}{\hbar} = \frac{\mu_{orb,\exp}}{\hbar} = -\frac{e}{m_e c} \qquad (6)$$

Let us **return** to the **relation** (4), **derived** by **theorists**, which contradicts the experimental one (3) due to the presence of the **number 2** in the denominator of the formula for $\mu_{orb,th}$ (5a):

$$\mu_{orb,th} = \frac{e\hbar}{2m_e c} = \frac{\upsilon_0}{2c} e r_0 . \qquad (7)$$

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**,

$$\mu_{orb} = (I / c)S \qquad (8)$$

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

$$I = e / T_{orb} \qquad (9)$$

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

Thus, on the basis of (8) and (9), physicists have come to the **expression** (**erroneous**, as we found out):

$$\mu_{orb,theor} = \frac{I}{c}S = \frac{1}{c}\left(\frac{e}{T_{orb}}\right)S = \frac{1}{c}\left(\frac{e\upsilon_0}{2\pi r_0}\right)\pi r_0^2 = \frac{e\hbar}{2m_e c} \qquad (10)$$

Question:

Where should we look for the mistake made in (10) ?

The answer is obvious:

In the average value of the electric current I (9), used in (10).

Physicists ***could*** and ***should have verified carefully*** the ***suitability*** of the equation (9) $I = e/T_{orb}$ (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. (9), they ***did not verify*** it, unfortunately.

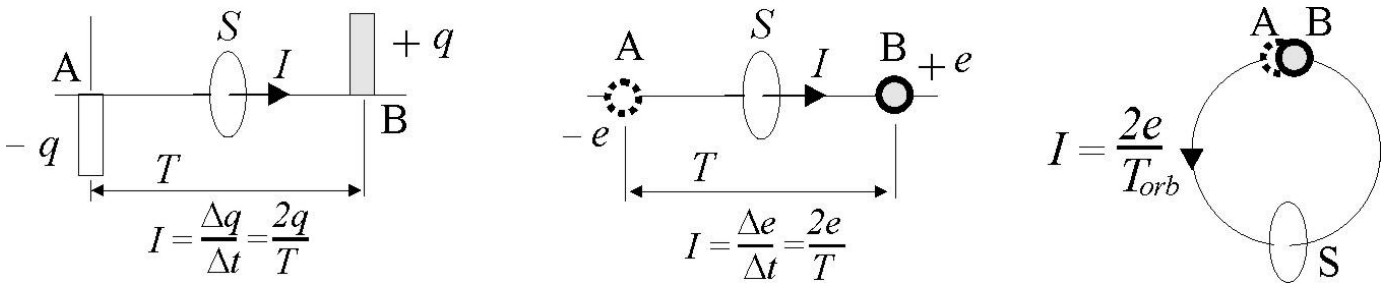
We have **filled this gap.**

Consider

What is the true average value of the current?

(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

$$I = \frac{\Delta q}{\Delta t} = \frac{e-(-e)}{T} = \frac{2e}{T} \qquad (11)$$

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**

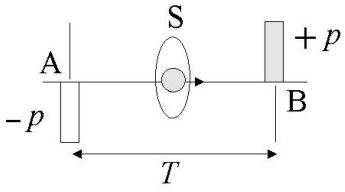
$$\boxed{I = \frac{2e}{T_{orb}}} \; !$$

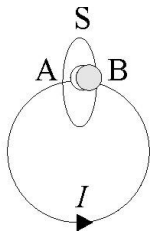
(12)

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

$$\langle I \rangle = 2p / T$$

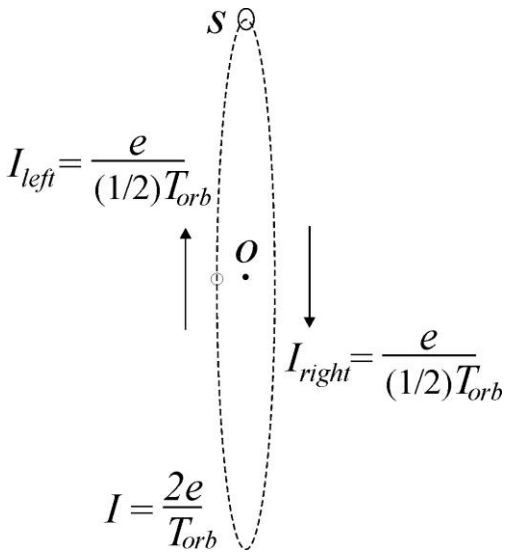




We **can come** to **formula** (12) **also** as follows, **without violating** the generally accepted **definition** of the notion of current in physics:

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:

$$I = I_{left} = I_{right} = \frac{2e}{T_{orb}} \qquad (13)$$

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:

$$2\pi r_0 = l = \frac{\lambda_1}{2} = \frac{\upsilon_0 T_0}{2} \quad \rightarrow \quad T_0 = \frac{4\pi r_0}{\upsilon_0} \qquad (14)$$

where υ_0 is the **wave speed** in the string, T_0 is the ***wave period***.

In the simplest **three-dimensional** case of solving the wave equation for a **spherical** field [3], we arrive at the **same equality** (14):

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 $2T_{orb}$,

$$T_0 = 2\left(\frac{2\pi r_0}{\upsilon_0}\right) = 2T_{orb} \qquad (15)$$

The average value of electrical current,

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

$$I = \frac{2}{iT}\int_0^{T/2} I_m e^{i\omega t}\,dt = \frac{2}{\pi} I_m \qquad \text{or} \qquad I = \frac{1}{2\pi i}\int_0^{2\pi} I_m e^{i\varphi/2}\,d\varphi = \frac{2}{\pi} I_m \qquad (16)$$

The **amplitude** of the elementary current I_m entering the expression (16) is

$$I_m = \left(\frac{dq}{dt}\right)_m = \omega_0 e = \frac{2\pi e}{T_0} \qquad (17)$$

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

Substituting (17) into (16), we obtain

$$I = 4e/T_0 \qquad (18)$$

Or, **since** $T_0 = 2T_{orb}$ (see (15)),

$$\boxed{I = 2e/T_{orb}}\ ! \qquad (19)$$

The **true value** of the **average current** (19) is **twice** the **value** $I = e/T_{orb}$ (9) **used** by theorists in **formula** (8) 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 **gross mistake** contained in the **formula** of the **average value** of electric **current** I produced by an **orbiting electron** [3, 4]**!** Didn't see its?

Thus, the mistake was found !

Substituting the **true value** of the **average** current (19) into the formula (8), we arrive at the **true value** of the **orbital magnetic moment** of the electron:

$$\mu_{orb} = \frac{I}{c} S = \frac{1}{c}\left(\frac{2e}{T_{orb}}\right)\pi r_0^2 = \frac{\upsilon_0}{c} e r_0 \qquad \text{or} \qquad \mu_{orb} = \frac{e\hbar}{m_e c} \qquad (20)$$

Hence, the **true ratio** of the **orbital magnetic** moment of the electron μ_{orb} (20) 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

$$\frac{\mu_{orb}}{\hbar} = -\frac{\upsilon_0 e r_0}{c m_e \upsilon_0 r_0} = -\frac{e}{m_e c} \qquad (21)$$

The **obtained** ratio of the moments (21) **coincides** with the **ratio** of the moments (gyromagnetic ratio) (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].

Interesting comparison:

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

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

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

Thus, $L_{own,Eth} / L_{orb,Eth} = 0.0000063.$

Imagine that the **own moment** of **momentum** of our **Earth** has become equal to **half** of its **orbital** moment of momentum, *i. e.*, $L_{own,Eth} / L_{orb,Eth} = 0.5$.

The Earth **will not be able** to **withstand** such a **huge** moment and will be **destroyed** (T_{own} of the Earth will be about $T_{own} = 4\pi \cdot J / L_{orb} \approx 1.091 s$! , as against $T_{own,Eth} = 86400\, s$).

Existence of an **electron** with “spin” equal to $\hbar/2$ (**regardless** of a permissible **size** that would have been **attributed to it**) is also (like Earth) **impossible**.

Estimated in the Wave Model [5], **own magnetic** moment of an electron is **insignificant**, $\mu_{spin} = 5.609964 \cdot 10^{-29}\ J \cdot T^{-1}$, that is 3×10^{-6} of the orbital one,

$\mu_{orb} = 1.855877461 \cdot 10^{-23}\ J \cdot T^{-1}$ (will be shown further).

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

All the **details** about the presented in this report can be found in the **Lectures** on the **Wave Model** [6].

Part 2

CONSEQUENCIES

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**:

$$\gamma = g\gamma_0 \qquad (1)$$

The **gyromagnetic ratio** γ for an **electron**, following from the experiment (of Einstein-de Haas, Barnett et al.) [1], is

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

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

$$\gamma_0 = \frac{\mu_{orb,th}}{\hbar} = -\frac{e}{2m_e c} \qquad (3)$$

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

$$g = 2 \qquad (4)$$

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 $\gamma_0 = \left(\frac{1}{2}\right)\frac{q}{mc}$ (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 (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 (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,

$$\mu_{orb,\exp}^{updated} > \mu_{orb,\exp} = -\frac{e}{m_e c}\hbar = -\frac{\upsilon_0}{c} e r_0 \qquad (5)$$

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 [1, 2]) ,

$$\mu_{orb,th} = \tfrac{1}{2}\mu_{orb,\exp} , \qquad (6)$$

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

$$\mu_{e,spin} = \mu_{orb,th} = \tfrac{1}{2}\mu_{orb,\exp} \qquad (7)$$

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

$$\mu_{orb} = \mu_{orb,th} + \mu_{e,spin} = \mu_{orb,\exp} = -\frac{e}{m_e c}\hbar , \qquad (8)$$

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:

$$\alpha_e = \frac{g_e - 2}{2} \qquad (9)$$

Taking into account (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 :

$$\mu_{e,spin} = -g_e \frac{e}{2m_e c}\left(\frac{\hbar}{2}\right) = -\frac{g_e}{2}\mu_B = -\mu_B(1+\alpha_e) \qquad (10)$$

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?

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 $4\times10^{14}\ g\cdot cm^{-3}$, 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**) [3].

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 [4] (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**.

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 (10).

However, as we have shown, the latter is a **fictitious parameter ascribed** to an electron **subjectively** (in addition to its **real** parameters, such as **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.

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

Since then, with increasing **accuracy** of the theoretical **derivation** of the values of "**anomaly**" and the **Lamb shift**, **using** the mythical **postulate**, for more than 60 years, modern **quantum electrodynamics** (**QED**) have **appeared** and **developed.**

On the basis of the accepted **postulate**, it was **began** an

elementary mathematical adjustment (fitting)

of the **calculated values** to the **experimental data** for both the "**anomalous**" magnetic moment of the electron and the **Lamb shift**.

The **adjustment continues** to this day in connection with obtaining more accurate experimental data, thanks to the progress in the experimental procedure, the appearance of supercomputers.

Calculation of «anomalous» magnetic moment of the electron

(in Quantum Electrodynamics, QED)

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 **derived for** the anomaly α_e (9) [5].

In fully expanded form the

Calculation formula

for the **anomaly** α_e (9), entering in the expression $\mu_{e,spin} = -(1+\alpha_e)\mu_B$ (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 [5]) :

$$\alpha_e = 0.5\left(\frac{\alpha}{\pi}\right) - 0.328478965579...\left(\frac{\alpha}{\pi}\right)^2 + 1.181241456...\left(\frac{\alpha}{\pi}\right)^3 -$$

$$-1.5098(384)\left(\frac{\alpha}{\pi}\right)^4 + 4.382(19)\times 10^{-12} = 0.00115965215 35(12) \qquad (11)$$

The alpha constant (α)

(entering into (11))

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

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

$\alpha = 7.2973525664\times10^{-3}$ (see [2014 CODATA recommended values])

Until now the **nature** of its **origin is** the greatest **mystery** for modern physics (for details, see [6]).

For those who will be interested in this:

The Wave Model revealed the physical meaning of the alpha constant:

The **α–constant** is a **fundamental** constant, reflecting the **scale correlation** of the **threshold conjugate** parameters, **oscillatory** and **wave**, inherent in the wave motion. It is **defined** by the **ratio**:

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

where υ_0 is the speed of the **electron** in the **first Bohr orbit (oscillatory** speed), c is the **wave** speed – the base speed of **propagation** of **waves generated** by the pulsating wave shell of the proton [7].

About numerical coefficients in Eq. (11)

An **example.** The **coefficient** at the **fourth term** of the expansion in (11), $(\alpha/\pi)^4$, 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 (11), $4.382(19)\times 10^{-12}$, 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 [8] and T. A. Welton [9], **thanks** to the **strenuous efforts** of physicists-theorists from **all over the world**.

Thus, the QED **formula** for the "**anomaly**" (11), 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 (11) [5] is equal to

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

Up to the 7th decimal place **this value** of the "anomaly" (12) **coincides** with the last value **recommended** for **use** in physics in 2016 [10].

The accepted **values** of all main **parameters** considering here, including (12), are given below:

The values of parameters related with the spin concept

recommended for **use** in physics in 2016 (CODATA [9])

1. ***Bohr magneton*** $\mu_B = 927.4009994 \cdot 10^{-26}\ J \cdot T^{-1}$ (13)

2. ***spin magnetic moment of an electron*** $\mu_{e,spin} = -928.4764620 \cdot 10^{-26}\ J \cdot T^{-1}$ (14)

$\mu_{e,spin} = -\mu_B(1+\alpha_e)$

3. ***«Anomaly» of the moment*** $a_e = 1.15965218091 \cdot 10^{-3}$ (15)

4. ***Electron g-factor*** $g_e = 2.00231930436182$ (16)

$g_e = 2(1+\alpha_e)$

The ***Bohr magneton*** μ_B is defined in 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 is **equal** to the **orbital** magnetic moment $\mu_{orb,th}$ and **spin magnetic moment** of an electron $\mu_{e,spin}$, **originally obtained** and **introduced in physics (**before taking into account the correction, "anomaly“, done later).

The ***spin magnetic moment*** of an electron $\mu_{e,spin}$, represents actually a **half** of the **orbital** magnetic moment of an electron in the Bohr orbit, which was **lost** due to erroneous calculations (at the theoretical description of the Einstein-de Haas effect).

Spin magnetic moment, $\mu_{e,spin}$, attributed to an electron, of the value (14),

is **mistakenly** associated with the **internal motion** of a **free electron.**

As we have shown, this moment represents the lost half of μ_{orb}, so that the **numerical value** ascribed to $\mu_{e,spin}$ is

actually related to the electron orbital magnetic momentum

just as the numerical value of μ_B (equal to $|\mu_{orb,th}|$).

Accordingly, in magnitude, the orbital magnetic moment of the electron

(in the Bohr orbit)

is equal to the **sum** of the **two** above **moments** (practically **equal** in value), (13) and (14), **recommended** for use **in physics**:

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

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

(the **effect** of the electron **proper motion** on the **orbital moment** is insignificant, $\alpha_e \approx 0.00116$).

Spin **magnetic moment** $\mu_{e,spin}$ of the **accepted value** (14)

has not been confirmed directly on free electrons

(unbound to atoms)

experimentally.

Its **value** was obtained by **subtracting** of $\mu_B = \left|\mu_{orb,th}\right|$ from $\mu_{orb,\exp}^{updated}$:

$$\mu_{orb,\exp}^{updated} - \mu_B = \mu_{e,spin}$$

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

$$\alpha_e = (\mu_{e,spin} / \mu_B) - 1$$

(see Eq. (10)), the experimental value of the **anomaly** α_e has become **known**.

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

As a result, despite the **great difficulties**, thanks to the **enormous effort**, the **formula** for α_e was **ultimately obtained** (Eq. (11)).

Thus, the true numerical value of the orbital magnetic moment of the electron is

$$\mu_{orb} = \mu_B + \mu_{e,spin} = \mu_{orb,\exp}^{updated} = -1855.8774614 \cdot 10^{-26}\ J \cdot T^{-1} \qquad (17)$$

The **first** term in (17) is the **erroneously calculated orbital** magnetic moment of the electron (**twice less** than experimentally obtained), **accepted** as a physical constant with the positive sign under the name the **Bohr magneton**, $\mu_B = |\mu_{orb,th}|$ (13).

The **second** term represents the "**lost**" half of the **orbital** magnetic moment of the electron (with allowance for the "**anomaly**"), **attributed erroneously** to a **free electron** as its internal parameter - the **own (spin) magnetic moment,** $\mu_{e,spin}$ (14).

Solutions of the Wave Model

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

directly lead to the same value (17) **of the orbital magnetic moment** μ_{orb} **.**

Solutions

of the

Wave Model

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 the wave nature, accordingly, they can be described by the general wave equation:

$$\Delta\hat{\Psi} - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}}{\partial t^2} = 0$$

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, the WM is a real alternative to the Standard Model of modern physics.

There is a series of **publications** devoted to the **WM**. They can be found on the **website** of the author, http://shpenkov.com, and 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) [11], and **Physics** (**Brussels**, Belgium) [12].

In [11, 12], there are links to **video** and **pdf-files** of the above presentations.

In the **Wave Model**, there are **no postulated** (invented) concepts, such as the electron "spin", and so on.

The above "**anomaly**" is explained in the WM as an effect of the **influence** of **intra-atomic wave** processes on the **orbital motion** of the electron, but in any way **not related** to the impact of mystical **virtual** photons on electron spin.

Insignificant perturbation (“anomaly”)
in the electron motion in an atom is due to the
wave structure and wave behaviour of its constituent particles
and 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** [2, 13].

Here is its **completely expanded** form:

$$\mu_{orb,WM} = -\frac{e\upsilon_0}{c}\left[r_0 + \left(\lambda\!\!\!^{-}_{e} + \frac{r_0}{b'_{0,1}} \right) \sqrt{\frac{4\pi R\hbar}{m_0 c}} + r_0 \frac{2\beta}{(y_{0,1} + y'_{0,1})} \sqrt{\frac{4\pi R\hbar_e}{m_e c}} \right] \quad ! \quad (18)$$

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

$$\mu_{orb,WM} = -1855.877614 \cdot 10^{-26}\ J \cdot T^{-1} \quad ! \quad (19)$$

completely coincides in magnitude with
the total magnetic moment of the orbiting electron (17)

(when **summing** the two components of the moment, (13) and (14),
recommended for use in physics in 2016)

Physical parameters

given in (18):

$b'_{0,1}$, $y_{0,1}$, $y'_{0,1}$ — the **roots** of **Bessel** functions (**radial solutions** of the wave equation);

R – the **Rydberg** constant; r_0 – the **Bohr** radius; υ_0 – the **Bohr** speed;

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

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

$\hbar_e$ – the **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 – the **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 – the **associated mass** of the proton; m_e – the **associated mass** of the electron;

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

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

Note

r_e , ω_e , $\hbar_e$, $\lambda\!\!\!^{-}_e$ – **fundamental** physical constants **following** from the **Wave Model**, previously **unknown** to modern physics;

e, m_0 , c – **fundamental** constants of **modern** physics, whose **true physical meaning** was **clarified** thanks to the **WM** (for e, it was discovered also its true **value** and **dimensionality** $g \cdot s^{-1}$).

The first term

in (18), $-\frac{\upsilon_0}{c} er_0$, corresponds to the **orbital magnetic moment calculated** by the equation (20, Part 1) (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 initially **obtained** (3, Part 1) in the Einstein-de Haas **experiments**, $\mu_{orb,\exp}$

$$-\frac{\upsilon_0}{c} er_0 = -\frac{e\hbar}{m_e c} = \mu_{orb,\exp} \qquad (20)$$

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** the correction, «**anomaly**», determined later):

$$\mu_{orb,\exp} = 2\mu_B = 2\mu_{e,spin} = \frac{e\hbar}{m_e c} \qquad (21)$$

The **next terms** in Eq. (18) **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*** $\lambda\!\!\!^{-}_{e}$ (the **oscillatory region** of the atom),

$$\delta\mu_{orb,1} = -\frac{e\upsilon_0}{c}\lambda\!\!\!^{-}_{e}\sqrt{\frac{2Rh}{m_0 c}} \qquad (22)$$

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 (18)) takes these oscillations into account :

$$\delta\mu_{orb,2} = -\frac{e\upsilon_0}{c}\frac{r_0}{b'_{0,1}}\sqrt{\frac{2Rh}{m_0 c}} \qquad (23)$$

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,

$$\delta\mu_{orb,3} = -\frac{e\upsilon_0 r_0}{c}\left(\frac{2\beta}{(y_{0,1}+y'_{0,1})}\sqrt{\frac{4\pi R\hbar_e}{m_e c}}\right) \qquad (24)$$

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** 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.

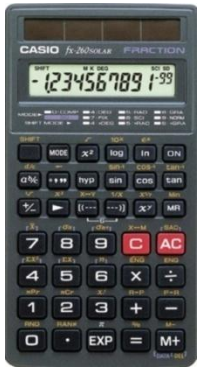
The contribution of $\delta\mu_{orb,3}$ to the total magnetic moment of the orbiting electron (19) is **insignificant**

$$\mu_{e,spin} = \delta\mu_{orb,3} = 5.609964 \cdot 10^{-29}\ J \cdot T^{-1} \qquad (24,a)$$

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.(18), **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 (18), 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** (18) can be presented (similar to equation (10) of QED for $\mu_{e,spin}$) as

$$\mu_{orb,WM} = -\frac{e}{m_e c}\hbar(1+\alpha_{e,WM}) \qquad (25)$$

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

From Eq. (18) for $\mu_{orb,WM}$, it **follows** that the **explicit** (complete) form of the **expression** for $\alpha_{e,WM}$ is:

$$\alpha_{e,WM} = \frac{1}{r_0}\left(\lambda\!\!\!^{-}_e + \frac{r_0}{b'_{0,1}}\right)\sqrt{\frac{4\pi R\hbar}{m_0 c}} + \frac{2\beta}{(y_{0,1}+y'_{0,1})}\sqrt{\frac{4\pi R\hbar_e}{m_0 c}} \qquad (26)$$

The indisputable **advantage** of this expression, obtained within the **WM**, is clearly seen when **comparing** it with an **incredibly cumbersome** formula for α_e (11) 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:

$$\mu_{e,WM} = -g_{e,WM}\frac{e}{m_e c}\hbar = -2\mu_B(1+\alpha_{e,WM}) \qquad (27)$$

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** of the **orbiting** electron is equal to

$$g_{e,WM} = (1+\alpha_{e,WM}) \qquad (28)$$

Since

$$g_{e,WM} = \left|\mu_{e,\exp}\right| / 2\mu_B = 1.000579826 \qquad (29)$$

the "**anomaly**" is:

$$\alpha_{e,WM} = g_{e,WM} - 1 = 5.79826\cdot 10^{-4} \qquad (30)$$

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.

Approaching the end, it should be recalled that

Orbital magnetic moment of an electron

$$\mu_{orb,WM} = -1855.877461 \cdot 10^{-26}\ J \cdot T^{-1} \quad (19)$$

following directly from the **Wave Model** (formula (18)),

coincides in magnitude
with the **orbital magnetic moment**

$$\mu_{orb,QED} = \mu_{e,spin} + (-\mu_B) = -1855.8774614 \cdot 10^{-26}\ J \cdot T^{-1} \quad (17)$$

following from **Quantum Electrodynamics** (QED)
(when **summing** the two components of the moment, (13) and (14), roughly equal in value)

The contribution to the magnitude (19) of the spin magnetic moment is **insignificant:** $\mu_{e,spin,WM} = 5.609964 \cdot 10^{-29}\ J \cdot T^{-1}$**.**

Thus, the ratio

of the magnetic moment to the moment of momentum

of the **orbiting** electron,

$$\frac{\mu_e}{\hbar} = \frac{e}{m_e c} \qquad (31)$$

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:

$$e = m_e \omega_e \qquad (32)$$

Substituting (32) into (31), we arrive at the following result:

$$\frac{\mu_e}{\hbar} = \frac{e}{m_e c} = \frac{\omega_e}{c} = \frac{1}{\lambda\!\!\!^{-}_e} = k_e \qquad (33)$$

The data obtained mean that the ***ratio of the moments*** (31) ***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** $\lambda\!\!\!^{-}_e$ [12, 13].

The above data are in accordance with the **objective theory** of **electromagnetic processes** (described in the WM) [4, Part 1]. Relations (33) are also **valid** for **proper** moments.

Rate 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**

$$\alpha_e = 0.5\left(\frac{\alpha}{\pi}\right) - 0.328478965579...\left(\frac{\alpha}{\pi}\right)^2 + 1.181241456...\left(\frac{\alpha}{\pi}\right)^3 -$$

$$-1.5098(384)\left(\frac{\alpha}{\pi}\right)^4 + 4.382(19)\times 10^{-12} = 0.00115965215 35(12) \qquad (11)$$

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 (11) with the explicit form of all integral expressions for the coefficients in the terms of the expansion.

Full explicit form **WM**

$$\alpha_{e,WM} = \frac{1}{r_0}\left(\lambda\!\!\!^{-}_e + \frac{r_0}{b'_{0,1}}\right)\sqrt{\frac{4\pi R\hbar}{m_0 c}} + \frac{2\beta}{(y_{0,1} + y'_{0,1})}\sqrt{\frac{4\pi R\hbar_e}{m_0 c}} \qquad (26)$$

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): recommended for use in physics (QED) and obtained within the Wave Model (WM)

The experimental data

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

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

Summery of results

I

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

This **mistake** was committed 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 a **closed contour**, was taken in the form:

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

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

Our research has shown that this **formula** is **erroneous**.

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

The **true** average **value** of the circular current is **twice as much**,

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

that has been convincingly **proven**.

II

Presented results provide **convincing arguments** to state 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 **mistake** in two times made by physicists-theorists in calculating μ_{orb} .

In modern physics, it is believed that with allowance for 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, has **nothing in common** (just as the **electron spin** of $\hbar/2$) with the **real parameters** actually **inherent** in the electron.

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

III

According to the **definition** **accepted in physics**, ***the gyromagnetic ratio*** γ ***of a particle or system is the ratio of its magnetic moment to its angular momentum***, and is equal to

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

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 a **mistake** in the calculations).

According to the Wave Model, the **gyromagnetic ratios**, γ and γ_e (for an electron), are **equal**, correspondingly, to

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

These expressions are valid for both orbital and own moments.

The **gyromagnetic** $\gamma = q/mc$ **ratio** 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 :

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

For this reason, apparently,

having convinced in the senselessness of such attempts:

The determination of the spin magnetic moment on

free electrons

is not undertaken in physics.

This is why, being a **fictional** parameter, the "**electron spin**“, as explained in **quantum physics**, is **not to be taken literally** in the classical sense as a mechanical rotation of an electron (where it is regarded as a tiny charged ball) around its own axis that must **condition** the **origin** of its own **magnetic moment** corresponding to the mechanical one.

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 **has faced great difficulties**.

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 , a **reduced variant** of which (11) only could been placed and **shown** here.

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 **rather simple** completely **explicit** form of the **formula** (18), in which the "**anomaly**" (α_e) was directly **taken** into account.

The **value** of the **orbital magnetic moment** of the electron (19)

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

obtained in the WM from Eq. (18) (note once more, without using the **postulate** on virtual particles) completely **coincides** with the last known **experimental** data (17).

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

Conclusion

After **introducing** a **postulate** on **electron spin** of $\hbar/2$, a whole series of the concepts, **related to** the **spin**, were introduced in physics:

> electron $\mathbf{g_e}$**-factor, anomaly** of electron spin magnetic moment**,** an erroneous "**classical value"** for gyromagnetic ratio, **general g-factor** for elementary particles**, virtual particles**, and *etc*.

In 1928, the **Dirac equation appeared**. Combining **quantum mechanics** and **relativity**, Dirac **rearranged** the Schrödinger equation in such a way that an electron **spin appeared** there...

As a result, **quantum field theory** – **quantum electrodynamics** (**QED**) – was created.

The **Dirac equation is** the **basic equation** of **QED**, represents the relativistic **generalization** of the **Schrödinger equation** (1925).

Schrodinger's equation, recall, is the basic equation of **quantum mechanics** (QM), and is **one** of its **six** basic **postulates**. Like the concept of **electron spin**, $\hbar/2$ in magnitude, Schrodinger's equation is **erroneous** as well that was **convincingly proved** (see, for example, [14-18]).

Thus, **Dirac's equation** became **yet another** abstract-mathematical **creation** in the **annoying chain** of **doubtful postulated concepts** accepted in physics, along with such of them as mentioned above.

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 variant, since it is **building** on a **ghostly foundation** – **fictional** abstract-mathematical **postulates**, subjectively introduced concepts.

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 $I = e / T_{orb}$ **for the average current generated by the orbiting electron!**

Surprisingly,
so far almost for a **century, no one paid attention to this formula (!),**
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 mistakes** – in full agreement with the **dialectical law** of **double negation**:

$$No_1 \cdot No_2 = Yes$$

where No_1 is the **initial lie**, No_2 is a **new lie**, and Yes is the **formal truth**.

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

However, not everything is so bad.

Judging by the **data** obtained, the **Wave Model**, based on the new paradigm, showed itself as a **real alternative** to the **Standard Model** (dominant in modern physics), and **can change** the **unfavourable trend**.

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