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Dm.I. Mendeleev

Some words about fundamental problems of physics. Part 2: «Electron spin»

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A very gross error was made by theorists to explain the experimental results obtained by Einstein and de Haas in their measurements of magnetomechanical (gyromagnetic) ratio [1]. From the experiment it follows that the ratio of the magnetic moment of an electron, moving along the Bohr orbit (they relied on the Bohr model of an atom), μ_e, to its mechanical moment, $\hbar = m_e \upsilon_0 r_0$, is equal to

$$\frac{\mu_{e,\exp}}{\hbar} = -\frac{e}{m_e c}. \tag{1}$$

This result exceeded the expected value (which follows from the theory) of

$$\frac{\mu_{e,theor}}{\hbar} = -\frac{e}{2m_e c} \tag{2}$$

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

Clearly in this situation it would be prudent to carefully check the validity of the appropriate basic formulas used in the derivation of the theoretical value. By definition, that modern physics holds still, the calculation of the orbital magnetic moment of an electron in an atom is realized by a simple formula, which determines the magnetic moment of a closed electric circuit,

$$\mu_{orb} = \frac{I}{c} S\,, \tag{3}$$

where I is an average value of circular current, S is an area of the orbit, c is the speed of light.

Following the physical definition of current used in electrical engineering, as the flow of electric charge ("electron fluid") in the conductor, the calculation of the average value of electric current generated by the orbiting electron was carried out (as it appears here, short-sighted and wrong) by the formula

$$I = \frac{e}{T_{orb}}, \tag{4}$$

where T_{orb} is the period of electron revolution along the orbit, e is the electron charge. Hence,

$$\mu_{orb,theor} = \frac{I}{c} S = \frac{e}{cT_{orb}} S = \frac{e\upsilon_0}{c2\pi r_0} \pi r_0^2 = \frac{\upsilon_0}{2c} e r_0, \tag{5}$$

that led to the ratio of the moments (2) twice less than the experimentally obtained value (1). One needed to find the error.

For some reason no one did not put the question, formula (4) is valid or not? This circumstance first had to draw the attention of theorists. The matter is that we are not dealing with a current of "electron fluid" (or "electron gas"), but with a current generated by a single electron charge, moreover, while moving along a closed circuit. We will try to fill the gap by revealing shortcomings and finding an answer to the above question.

1. Let us consider what in fact the average value of current creates a single (discrete) charge, moving along a closed path.

In a general case, the charge transfer of the electron e through any cross section S along any path during the time T is accompanied with disappearance of it from one side (-e, point A) and the appearance on the other side (+ e, point B) of an arbitrary cross section, as shown in Fig. 1.

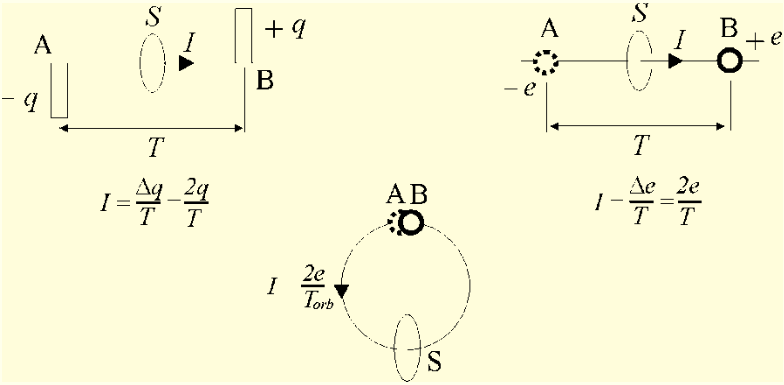

Fig. 1. The charge transfer of the electron e through any cross section S of a conductor.

Let me explain again. During a period of time T: disappearance of the charge from the left side means REDUCTION of the charge at this side from the value of +e up to 0, i.e. the reduction on the amount of charge –e. And appearance of the charge on the right side of the cross section means GAIN of the charge at this side from the value of 0 up to +e, i.e. the gain on the amount of charge +e. Thus, during the time T, the complete charge change is $\Delta e = +e - (-e) = 2e$. Hence, an average rate of the charge change (current I) during the time T is

$$I = \frac{\Delta e}{T} = \frac{(e - (-e))}{T} = \frac{2e}{T} \qquad (6)$$

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

$$I = \frac{2e}{T_{orb}}, \qquad (7)$$

where T_{orb} is the period of electron's revolution on a circular orbit.

Additionally, for more clarity, we can come to the derivation (7) from another side without disturbing the existing logic in the accepted concept of determining the average current. To do this, let us deform the orbit, pressing it. As a result, we obtain something like a closed two-wire line as shown in Fig. 2.

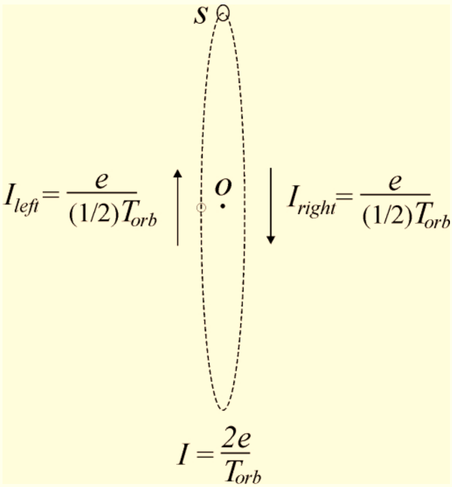

Fig. 2. An average current in a closed two-wire line

How many times do you think, one orbital electron moving along the closed loop (i.e., during one complete revolution, T_{orb}) and passing in the vicinity of the point "O", first up (the average current in the left half of the trajectory is $I_{left} = e/(1/2)T_{orb}$), and then down (the average current on the right half of the trajectory is $I_{right} = e/(1/2)T_{orb}$), creates a transverse (vortical) magnetic field at that point?

As they say "no brainer" that two times: at first moving on the left and then on the right side of the trajectory near the center "O". It's like that 2 charges slipped... I wonder, is it? In this case the usual formula, which follows from the definition of the average current adopted in physics ($I = e/T$) is not violated. The average value of current on both sides and, therefore, around a whole closed two-wire line is the same and equal to

$$I = I_{left} = I_{right} = 2e/T_{orb}$$

2. Since the electron, just like any other elementary particle, manifests the duality, behaves as a particle and as a wave, without any doubts it is reasonable and necessary to derive the formula of the average current for the case of the wave motion of the electron.

a) Let's start with the one-dimensional problem. From the well-known solution of the wave equation for the 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, $l = \frac{\lambda_1}{2}$. If we join the ends of the string together, then we obtain a circle of the length $l = 2\pi r_0$ with one node. As a result, we come to the equality

$$2\pi r_0 = \frac{\lambda_1}{2} = \frac{\upsilon_0 T_0}{2}, \tag{8}$$

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

б) In the simplest case of three-dimensional solutions of the wave equation for a spherical field [1] we arrive at the same equation (8): only one half-wave of the fundamental tone is placed on the Bohr orbit, and the electron is in a node of the wave.

Thus (see (8)), the wave period of the fundamental tone at the wave surface of the radius r_0 is equal to

$$T_0 = \frac{4\pi r_0}{\upsilon_0}. \qquad (9)$$

Average current as the harmonic magnitude is determined by the known formulas:

$$I = \frac{2}{iT}\int_0^{T/2} I_m e^{i\omega t}dt = \frac{2}{\pi}I_m \quad \text{или} \quad I = \frac{1}{2\pi i}\int_0^{2\pi} I_m e^{i\phi/2}d\phi = \frac{2}{\pi}I_m \qquad (10)$$

The amplitude of the elementary current I_m, in the expression (10), is

$$I_m = \left(\frac{dq}{dt}\right)_m = \omega_0 e = \frac{2\pi e}{T_0}, \qquad (11)$$

where ω_0 is the frequency of the fundamental tone of the electron orbit. Thus, substituting (11) in (10), we obtain

$$I = \frac{4e}{T_0}. \qquad (12)$$

or, as $T_0 = 2T_{orb}$,

$$I = \frac{2e}{T_{orb}}. \qquad (13)$$

In [1] there presented also other options of the derivation for the average value of current for an electron moving in a circular orbit. They all give the same value defined by the formula (13), but not by (4). The notion of electric current and the related problem of electron spin are analyzed in detail in the fundamental book "Atomic Structure of Matter-Space" (2001) [2]. It's quite comprehensive material, in which all the questions that just might be are analysed and solved. In particular, a small fragment of the book, namely paragraphs 9 and 10 of Chapter 9 (from 453 to 494 pages), which examines the concept of current, is available online on the internet in PDF format [3].

Thus, the problem is solved, an error is found. The resulting formula for the circular current differs from that used by theorists (4) in their consideration of the aforementioned experiment by the presence of a factor of 2. Substituting the average value of current (13) into (3), we find the correct formula (logically, physically and mathematically conditioned) to calculate the electron's orbital magnetic moment, which at anybody can no longer call doubts.

$$\mu_{orb} = \frac{I}{c} S = \frac{2e}{cT_{orb}} \pi r_0^2 = \frac{\upsilon_0}{c} e r_0 . \tag{14}$$

Hence, the ratio of the orbital magnetic moment (14) to its mechanical moment (the moment of its orbital momentum, $\hbar = m_e \upsilon_0 r_0$), taking into account the sign (the opposite direction of moments), is equal to

$$\frac{\mu_{orb}}{\hbar} = -\frac{\upsilon_0 e r_0}{c m_e \upsilon_0 r_0} = -\frac{e}{m_e c} . \tag{15}$$

The resulting ratio of moments, the theoretical derivation of which is given above, coincides with the ratio of the moments (the gyromagnetic ratio) (1) obtained in experiments of Einstein-de Haas and Barnett.

CONCLUSION

The true value of the intrinsic magnetic moment of an electron bound in an atom is negligible compared to the value ascribed to him at half the orbital magnetic moment (equal to the Bohr magneton). What is its specific value and how it was calculated one can find in [4].

I hope that we have shown enough clear and convincingly that if 100% trust the experimental results, it is true that theorists should first find an obvious mistake in the formula used by them in the calculation of the electric current generated by a single discrete charge (electron) moving in an orbit, but not engage in fantasy. The strength of current I is the only physical quantity which determines the magnetic moment (at constant c and S, see Eq. (3)).

In the mathematical formulation of the definition of the electric current accepted in physics, for the particular case which is the motion of a single charge on a closed path, one had to be careful and think (for good reason there is a saying: "look before you leap, cut once"). This is an elementary task, cope with it and school children and students; it is good for the development of their thinking.

It seems simple, "as the rake", but for some reason, this problem was not resolved by theorists, apparently, simply was not considered by them. Unfortunately, as a result of this their explicit, to say the least, flaws physics has taken the wrong way. To get out of the situation being faced with their result (2), theorists have preferred to follow the trodden path of their predecessors and brought about his own postulate about an intrinsic mechanical moment of the electron called then an electron spin. Namely to find the missing half in the calculations, resulted in the ratio (2), to fit the latter to the experimental ratio (1), they ascribed to the electron, in addition to its real (intrinsic) properties such as mass and charge, a virtual (mythical) and, therefore, unreal property, spin. As a consequence, there appeared the mythical electron spin magnetic moment, corresponding to the mythical spin, the absolute value of which was called the Bohr magneton, μ_B:

$$\mu_{spin} \equiv \mu_B = \mu_{orb,theor} = \frac{\upsilon_0}{2c} e r_0 \tag{16}$$

With the help of a mythical spin magnetic moment, theoreticians "closed the gap" in their calculations of the gyromagnetic ratio (2). Thus, the "lost" (in their calculations) half of the orbital magnetic moment of the electron, bound in an atom, was called by theorists the electron spin magnetic moment. Then this "lost" orbital half (under the name, spin magnetic moment or the Bohr magneton) was fastened to the received theoretically half of the orbital magnetic moment (5).

$$\mu_{e,theor} = \mu_{orb,theor} + \mu_{spin} = \frac{\upsilon_0}{2c} e r_0 + \frac{\upsilon_0}{2c} e r_0 = \frac{\upsilon_0}{c} e r_0 \tag{17}$$

Put together the two halves, actually, of the same orbital magnetic moment have been named the total magnetic moment of an electron in an atom, $\mu_{e,theor}$. As a result of such an obvious and explicit fitting, the complete coincidence with the experimentally obtained gyromagnetic ratio (1) was achieved:

$$\frac{\mu_{e,theor}}{\hbar} = \frac{\mu_{orb,theor} + \mu_{spin}}{\hbar} = \frac{\mu_{e,\exp}}{\hbar} = -\frac{e}{m_e c} \tag{18}$$

It was an epoch-making error; it marked the beginning of the present spinmania in physics, which continues to this day. At the present time, modern physics cannot exist without the notion of spin. To someone, apparently, it was truly necessary to discard the humanity in his cognition of nature to centuries ago, directing physics in a wrong direction to create a virtual reality: driving physics in a dead end, to hinder the development of our civilization. Consciously or not, but in this kind of absurd (virtual) creations of the 20th century, many eminent theoretical physicists of that time took part...

One should be noted that the relatively enormous absolute value of $\hbar/2$ was attributed to electron spin that is comparable with the value of electron's angular orbital moment. With this it is believed that an existence of the intrinsic mechanical moment, spin, of the electron of such a magnitude was confirmed experimentally. However, where is the direct evidence? Where are experiments to determine the spin on free electrons, but not on the electrons which bound to atoms? They are not.

Thus, explaining a series of phenomena observed experimentally, physicists, using the mythical (fabricated, postulated) concepts such as the electron spin, considered here, or like the virtual particles of quantum electrodynamics (which will be discussed later), draw a distorted picture of reality, in fact, they create virtual, mythical world (science fiction).

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