Some words about fundamental problems of physics

Part 9: The proton magnetic moment

George Shpenkov

In this Part of the article I will describe briefly, as it was done in the previous eight Parts, only about major aspects of the derivation of the proton magnetic moment accentuating attention on the logic and meaning of certain actions undertaken in this case. All the details of the derivations are contained in the paper [1] available online on the Internet. The indicated paper is a continuation of the work devoted to the theoretical derivations of the magnetic moments of an electron [2, 3] and a neutron [4], and the derivation of the Lamb shift [5], performed in the framework of the Wave Model (WM) by a theory of the Dynamic Model (DM) of elementary particles [3, 6]. The material presented here is closely related with the previous Part 8; therefore one should familiar with its contents before to begin reading this Part.

The charges and their behaviour are responsible for the magnetic properties of elementary particles. But what solution on the magnetic moments of the particles can be expected from the theories of the Standard Model (SM) dominated currently in physics, which do not know the nature of the charges, what is the charge? The same ignorance relates to the origin of the mass of the particles. The mass and the charge are the main parameters of elementary particles of which all the physical bodies consist; they are the primary fundamental concepts of physics. These parameters are, unfortunately, an unfathomable mystery, *terra incognita*, for modern physics with its SM.

Therefore, all the attempts of physicists in the framework of the SM, by means of quantum electrodynamics (QED) and quantum chromodynamics (QCD), in fact, blindly, to explain the "anomalous" magnetic moments of nucleons caused by the charges, on the nature of which they know nothing, are nonsensical and, of course, doomed to failure. Please, read in this regard Part 3, in which it was shown what efforts were required to QED theorists to fit to the experiment the "anomalous" magnetic moment of an electron that they “derived” at last for more than half a century with the high accuracy, about what they are so proud today.

About the shortcomings of the SM every physicist knows, but the official physics is not going to abandon it, trying all the time to somehow improve this model. However, the embellishment of the rotten foundation and patching holes in it aggravates the stalemate and stagnation in theoretical physics in even more extent. In construction, for example, no one would do so, but would to pull down the old foundation (or leaving it to rot on further) and all the forces would give up on building a new one.

Currently, there appear works in which the realistic approach is dominated. This approach is connected with a return to clear physical images and ideas inherent in classical physics. The classical approach was arbitrarily and hastily neglected beginning from the last century, for the sake of the quantum theory appearing in that time. A thorough analysis of the foundations of physics [7] showed that the possibilities of classical physics are still far from exhausted. As a result of the analysis, in the framework of the wave approach (the WM), the wave theory of elementary particles (the DM) [3, 6] was developed. Its solutions proved to be very effective, as evidenced, in particular, by the results presented in all previous Parts of this analytical paper.

Thus, the derivation of the proton magnetic moment is impossible without the knowledge of the true nature of charges. Therefore, let me first to present in this regard some necessary notions and definitions related to the discovery (in the DM) the origin of the mass and the nature of charges.

In accordance with the DM, the rest mass of elementary particles does not exist, and the mass, that we take for granted, it turns out, has the *associated wave nature*, and is a measure of exchange (interaction). The concept of "exchange" instead of "interaction" is one of the fundamental concepts of the DM. Two types of exchange, as two opposite sides of the interaction between the particles and the surrounding field, are distinguished: *longitudinal* and *transversal*. *Longitudinal exchange* is characteristic for spherical fields of particles in rest and motion. *Transversal exchange* is inherent in cylindrical fields of moving particles.

Intensity (rate) of the wave mass exchange determines the *exchange charges*. Their dimensionality is $g \times s^{-1}$**.** Exchange charges are responsible for the electric and magnetic properties of particles. Thus, the so-called “electric” and “magnetic” charges inherently relate to the wave exchange of particles; therefore the charges are called the “exchange” ones. According to the DM, there are two types of exchange charges corresponding to two types of exchange: *longitudinal* ("electric") exchange charges and *transversal* ("magnetic") exchange charges. The transversal charge arises when moving particles. Thus, so far unsolved mystery of the nature of the charges (“electric” and “magnetic”) revealed, finally, in the DM.

Now, after such a necessary introduction, we can proceed directly to the derivation of the proton magnetic moment. For this, we should first to remind some features of the neutron because in both (proton and neutron) cases, we use the same approach and, hence, the same equations. With this, some fragments of the solutions are valid for both.

The neutron is considered in the DM as a coupled proton-electron wave system, and as a whole it is an electrically neutral microformation. In a free state (see Part 8), the neutron is unstable. Due to the exchange charges, longitudinal and transversal, the continuous equilibrium wave exchange (interaction) between the longitudinal and transversal fields of constituent particles of the neutron (proton and electron) is implemented in it. The longitudinal positive exchange charge of the basis (proton) and the transversal negative exchange charge of the electron moving in the system cancel each other. Consequently, being a neutral particle, the neutron as a whole does not generate in its motion the transversal exchange charge. But as in the case of a hydrogen atom, a negative exchange charge of the electron causes the negative magnetic moment of the neutron.

A free proton has the longitudinal ("electric") exchange charge equal in magnitude to the elementary (minimal) quantum of the rate of mass exchange. The longitudinal exchange charge of the proton is not compensated, in contrast to the neutron; and, therefore, in its motion the proton generates additionally the transverse charge, which together with its not compensated longitudinal charge is responsible for the magnetic properties. Both the wave exchanges and the corresponding exchange charges, longitudinal and transversal, are responsible for the existence of the magnetic moment of the proton.

Thus, the total exchange charge of the proton, q, is determined by the positive not compensated exchange charge, $+e$, and the additional, associated, transversal exchange charge, Δe_p:

$$q = +e + \Delta e_p . \tag{1}$$

The derivation of the proton magnetic moment repeats the derivation of the neutron magnetic moment [4] up to the stage related to the contribution caused by the electron; therefore, there is no need to repeat it here. Taking into account Eq. (1) and two first terms of Eq. (7) (from Part 8) related to the neutron magnetic moment, which are valid for the proton, we obtain the following theoretical formula for the total magnetic moment $\mu_p(th)$ of the proton:

$$\mu_p(th) = \frac{(e + \Delta e_p)\upsilon_0}{c}\left(\bar{\lambda}_e + \frac{r_0}{z_{0,s}}\right)\sqrt{\frac{2Rh}{m_0 c}} . \tag{2}$$

The values of all the parameters in the formula (2) are known, except of Δe_p, and are provided in Part 8. The transversal charge, Δe_p, is unknown so far for modern physics the physical parameter, its nature is considered in detail in [1, 7]. The transversal exchange is directly related to the longitudinal exchange. Both above exchanges are fundamental concepts of the DM, they reflect the true regularities of nature.

The exchange charge in the DM, as a measure of the rate of mass exchange (interaction), is the product of the associated mass m and fundamental frequency ω_e of the exchange at the subatomic and atomic levels ($\omega_e = 1.869162534 \times 10^{18}\ s^{-1}$):

$$q = \frac{dm}{dt} = m\omega_e , \tag{3}$$

Hence, the transversal exchange charge Δe_p is defined by the following equality,

$$\Delta e_p = \Delta m_p \omega_e , \tag{4}$$

where Δm_p is the additional associated (transversal) mass of the proton. It is calculated, according to the DM, by the following formula

$$\Delta m_p = \frac{4\pi r_0^2 l \varepsilon_0}{1+4k_e^2 r_0^2}, \tag{5}$$

where

$$l = \frac{e}{2\pi r_0 c \varepsilon_0} = 1.708182574 \cdot 10^{-12}\ cm \tag{5a}$$

is the length of an elementary (minimal) part of the cylindrical surface of the cylindrical (transversal) field around a trajectory of the moving proton, corresponding to an elementary transversal magnetic charge-flow at the level of the Bohr radius, and at the speed of exchange equal to *c*; $e = 1.702691582 \cdot 10^{-9}\ g \cdot s^{-1}$ is the charge of exchange of the proton with environment equal, in absolute value, to the electron exchange charge (i.e., to the elementary quantum of the rate of mass exchange); r_0 is the Bohr radius; $\varepsilon_0 = 1\, g \cdot cm^{-3}$ is the absolute unit density; $k_e = \omega_e / c$ is the fundamental wave number.

Calculations by the formulas (4) and (5) give the following values for the associated additional (transverse) mass, Δm_p, and the associated extra (transversal) exchange charge of the proton, Δe_p:

$$\Delta m_p = \frac{4\pi r_0^2 l \varepsilon_0}{1+4k_e^2 r_0^2} = 4.187602162 \cdot 10^{-28} g, \qquad m_0 = 1.672621637(83) \cdot 10^{-24} g \tag{6}$$

$$\Delta e_p = \Delta m_p \omega_e = 7.827309069 \cdot 10^{-10}\ g \cdot s^{-1}, \qquad e = 1.702691582 \cdot 10^{-9}\ g \cdot s^{-1} \tag{7}$$

For comparison, to the right, there are shown the associated (longitudinal) mass of the proton, m_0, and the value of the elementary exchange charge, + *e*. Thus, the total exchange charge of the proton wave shell with the surrounding space is

$$q = e + \Delta e_p = 2.485422489 \cdot 10^{-9}\ g \cdot s^{-1}. \tag{8}$$

We now can return to the formula (2). Similarly as in the case of theoretical derivation of the neutron magnetic moment, we choose solutions of Bessel functions near the 12th wave shell. Because of greater uncertainty we take the average of two adjacent roots of $z_{0,s}$: $a'_{0,11} = 32.95638904$, equal to the extremum of the 11th potential wave spherical shell, and $y_{0,12} = 35.34645231$, equal to the zero of the 12th kinetic wave shell [8]. Under these conditions Eq. (2) takes the following detailed form:

$$\mu_p(th) = \frac{(e+\Delta e_p)\upsilon_0}{c}\left(\lambda\!\!\!^{-}_e + r_0\,\frac{(a'_{0,11}+y_{0,12})}{2(a'_{0,11}y_{0,12})}\right)\sqrt{\frac{2Rh}{m_0 c}}\,, \tag{9}$$

where $\upsilon_0 = \alpha c = 2.187691254 \cdot 10^8\ cm \cdot s^{-1}$ (α is the fine-structure constant [9]). After substituting the numerical values we obtain:

$$\begin{aligned}\mu_p(th) &= (1.397094734 + 0.0135137738)\times 10^{-26}\ \ J\cdot T^{-1} = \\ &= 1.410608508\times 10^{-26}\ J\cdot T^{-1}\end{aligned} \tag{10}$$

The experimental value (recommended by CODATA in 2006) is:

$$\mu_{p,CODATA} = 1.410606662(37)\cdot 10^{-26}\,J\cdot T^{-1} \tag{11}$$

We see a fairly high accuracy (up to the 5th decimal) of coincidence of the calculated value (10) and the averaged experimental value (11) for the proton magnetic moment. The absolute agreement between two variables (theoretical and experimental), up to the last decimal places, one can easy achieve by introducing an empirical coefficient $1/\beta$ for the second term in (9). Such an action is quite acceptable, since by this way we can adjust the possible uncertainty which could naturally arise from the averaging of weight contributions of each of the two roots of the Bessel functions in (9) (corresponding to the chosen wave shells).

Assuming $\beta = 1.000136546$, we get the absolute coincidence of the calculated and experimental values of the proton magnetic moment:

$$\mu_p(th) = \frac{(e+\Delta e_p)\upsilon_0}{c}\left(\lambda\!\!\!^{-}_e + r_0\,\frac{1}{\beta}\,\frac{(a'_{0,11}+y_{0,12})}{2(a'_{0,11}y_{0,12})}\right)\sqrt{\frac{2Rh}{m_0 c}} = 1.410606662\times 10^{-26}\ \ J\cdot T^{-1}. \tag{12}$$

Thus, for the first time in physics, the theoretical derivation of the proton magnetic moment has been realised, similarly as for the neutron (see Part 8), moreover, with absolute accuracy and without the involvement of virtual concepts of the QED and QCD theories. This proven to be possible theoretically owing to the Dynamic Model - a new physical theory - the wave theory of elementary particles that takes into account the wave structure and behaviour of elementary particles.

The accurate derivation of the proton magnetic moment in the DM, impossible in the framework of the SM, confirms once again the advantage of the wave approach developed by the author. There proved the reality of the fundamental discoveries made in the DM, such as: (a) the wave associated nature of the mass of elementary particles, and (b) the wave nature of the exchange charges ("electric" and "magnetic"), and (c) the values of the fundamental frequencies at which the exchange (interaction) with other particles and the environment occurs at subatomic and atomic, and gravitational levels. The charges, regarded in physics as "electric" and "magnetic", represent the rate (intensity, power) of the wave mass exchange, longitudinal and transversal, respectively, that is reflected in their true dimensionality of $g \times s^{-1}$.

REFERENCES

[1] G. P. Shpenkov, *Derivation of the Proton's Magnetic Moment beyond QED and QCD Theories*; http://shpenkov.janmax.com/ProtonMagMom.pdf

[2] G. P. Shpenkov, *The First Precise Derivation of the Magnetic Moment of an Electron Beyond Quantum Electrodynamics*, Physics Essays, 19, No. 1, (2006).

[3] G. P. Shpenkov, *Theoretical Basis and Proofs of the Existence of Atom Background Radiation,* Infinite Energy, Vol. 12, Issue 68, 22-33, (2006); http://shpenkov.janmax.com/TheorBasis.pdf

[4] G. P. Shpenkov, *Derivation of Neutron's Magnetic Moment on the Basis of Dynamic Model of Elementary Particles*, (2008); http://shpenkov.janmax.com/neutronmagmom.pdf

[5] G. P. Shpenkov, *Derivation of the Lamb Shift with Due Account of Wave Features for the Proton-Electron Interaction*, REVISTA de CIENCIAS EXATAS e NATURAIS, Vol. 6, No. 2, 171 - 185, (2004); http://shpenkov.janmax.com/derivation.pdf

[6] L. G. Kreidik and G. P. Shpenkov, *Dynamic Model of Elementary Particles and the Nature of Mass and "Electric" Charge*, REVISTA CIENCIAS EXATAS E NATURAIS, Vol. 3, No 2, 157-170, (2001); http://www.unicentro.br/editora/revistas/recen/v3n2/trc510final.pdf

[7] L. G. Kreidik and G. P. Shpenkov, *Atomic Structure of Matter-Space*, Geo. S., Bydgoszcz, 2001, 584 p.; http://shpenkov.janmax.com/atom.asp

[8] Bessel Functions, part. III, Zeros and Associated Values, in *Royal Society Mathematical Tables*, Volume 7, edited by F. W. J. Olver (University Press, Cambridge, 1960).

[9] G. P. Shpenkov, *On the Fine-Structure Constant Physical Meaning*, HADRONIC JOURNAL, Vol. 28, No. 3, 337-372, (2005); http://shpenkov.janmax.com/AlphaConstant.pdf

25.07.2011