# ANOMALOUS MAGNETIC MOMENT OF THE ENTANGLED ELECTRON WITHOUT Q.E.D.

Lino Zamboni, Doctor of Nuclear Engineering
lino.zamboni@gmail.com

ABSTRACT

In 1965, the Nobel Prize was awarded for the modern formulation of Quantum Electrodynamics (QED) to R.P. Feynman for his diagrammatic method, J. Schwinger for the operator method, and S.-I. Tomonaga for his relativistic derivation. Subsequently, P. Kusch performed a precise measurement of the electron's anomalous magnetic moment, providing a critical test validating QED's computational methods, which proved to be extremely accurate.
Nevertheless, QED is based on a physically unrealistic assumption—mathematically circumvented—that the electron is a dimensionless point particle endowed with physical properties "ex abrupto."
This work, developed within a deterministic and non-local dBBZ (modified de Broglie–Bohm) theory, models the electron as an entangled and distributed structure, as proposed in previous studies. It enables the calculation of the electron's anomalous magnetic moment as a consequence of its intrinsic structure, without employing QED techniques.
The method involves calculating, for each orbital, the anomalous moment modified to account for the influence of existing magnetic fields. Subsequently, entanglement is imposed on the sum of these moments, and from the total orbital anomalous moment thus obtained, the theoretical magnetic anomaly is derived and compared with the corresponding experimental value, yielding relative errors on the order of 10^-12.
This procedure, which allows for greater theoretical precision than current methods, necessitates a similar, albeit more complex, calculation of the muon's anomalous magnetic moment. This is because a specific parameter, termed the "source parameter," selected within an allowable range, requires dual verification to be adopted with high precision.
The theoretical determination of the muon's anomalous magnetic moment is also presented in a subsequent document, employing analogous computational procedures.

## 1) INTRODUCTION

The electron's structure, presented in previous works,[1][2][3] is formalized in its essential part by the matrix Mze or the expression Z, and is completed by additional information such as the correction ZC ,which highlighs the electromagnetic component , and expressions determining the stationarity and entanglement of the orbitals constituting the electron itself.

The articulation of this information constitutes the integrated structural model of the electron, which we reference in its entirety for determining the magnetic anomaly, an intrinsic feature of the electron's overall structure.

We dedicate an initial section to determining, for each orbital, the magnetic field energy, calculated through the electric field energy due to the charges present in the various orbitals.

We then demonstrate, through an appropriate energy balance, how the velocities of the charges (and associated masses) are influenced by the presence of the aforementioned magnetic fields.

This influence on velocities results in a variation of the anomalous momentum on each orbital (hereafter: orbital anomalous moment), defined as:

1) $L_i = m_i v_i r_{m_i}$

The sum of the orbital anomalous moments, adjusted by normalization coefficients due to the imposed entanglement among them, constitutes the total anomalous moment.
From this, the theoretical value of the magnetic anomaly can be deduced and compared with the respective experimental value, yielding the relative error.

This work continues concepts and calculations developed in previous documents:

viXra 2411.0050 -2412.0092 -2503.0010 Quantum Physics, which are referenced for symbols and results of partial or total calculations.

The International System (SI) is adopted, and constants are consistent with CODATA 2022.

Appendices provide examples of numerical developments related to the adopted expressions.

The sign of electric charges is not considered unless explicitly indicated.The spin value is always considered as a positive scalar.

## 2) INFLUENCE OF MAGNETIC FIELDS

The determination of electrostatic energy is calculated by considering the source potential at the distance of the considered orbital and the charge "seen" by that orbital.

Calculating the source potential presupposes adopting the model of partial unification of[5][6] the electroweak interaction, estimated within the range: $\alpha_{ew} = 0{,}03 \div 0{,}04$ ,at the precise value: $\alpha_{ew} = 0{,}0326292828 78$

This value, crucial for the precision of the magnetic anomaly calculation, will be confirmed in other cases, particularly concerning the calculation of the muon's and tauon's magnetic anomaly.

The source potential is given by:[3]

2) $V_{q_s} = \dfrac{q_s}{4\pi\varepsilon_0 r}$ with:

3) $q_s = \sqrt{4\pi\varepsilon_0 \hbar c \cdot \alpha_{ew}} \simeq 3{.}387907099657 \cdot 10^{-19}$ [Coulomb]

The source charge: $q_s$ can be written as: $q_s = n_q \cdot e$ where $n_q$ is defined as the source parameter: $n_q \simeq 2{,}114565290594$

The potential on the i-th orbital is calculated at the distance:

to implicitly account for the stationary equilibrium of the orbital itself.

The charge seen by the i-th orbital can be written as:

4) $q_T = e - 2 \cdot \sum_{i=1}^{n} q_i$ with: $q_i = e \cdot \frac{K_i}{K_T}$

We define the electrostatic energy as:

5) $E_{\epsilon_i} = V_q \cdot q_{iT} = \frac{q_s}{4\pi\varepsilon_0} \left(e - 2\sum_{l=1}^{i} d_l \cdot q_l\right) / \left(r_{m_i} / nq\right)$ [a]

We reduce the calculation of magnetic energy to that of electrostatic energy: [2]

6) $E_{B_i} = E_{\epsilon_i} \cdot v_i^2 / 4\pi c^2$

For each orbital, we write the energy balance between two conditions:

Condition "a" refers to the presence of kinetic energy only.

Condition "b" refers to the presence of kinetic energy and magnetic energy due to the movement of charges in the orbital.

Each orbital is considered a closed system; thus, the presence of magnetic energy causes a decrease in kinetic energy in the same orbital:

7) $0.5\, m_i \cdot v_{a_i}^2 = 0.5\, m_i \cdot v_{B_i}^2 - E_{\epsilon_i} v_{B_i}^2 / 4\pi c^2$ $\left(v_{a_i} = v_i = c\sqrt{2K_i}\right)$ [2]

where $E_{\epsilon_i}$ is always negative, ensuring the added magnetic energy is always positive.

We are interested in the velocity assumed in the condition: kinetic energy + magnetic energy:

8) $v_{B_i} = v_{A_i} \cdot \sqrt{0.5\, m_i / 0.5\, m_i - E_{\epsilon_i} / 4\pi c^2}$

Inserting (5) into (8), we obtain the final expression of $v_{B_i}$:

9) $v_{B_i} = v_{a_i} \cdot \sqrt{0.5\, m_i / \left[0.5\, m_i - \frac{q_s}{4\pi\varepsilon_0}\left(e - 2\sum_{l=1}^{i} d_l \cdot q_l\right) / \left(4\pi\, r_{m_i} c^2 / nq\right)\right]}$

We report the values of $v_{a_i}$, $v_{B_i}$ and their ratio : $X_i = v_{B_i} / v_{a_i}$ for the first 10 orbitals:

| $S_i$ | $v_{a_i}$ | $v_{B_i}$ | $X_i$ |
|---|---|---|---|
| 1 | $2{,}18769 \cdot 10^6$ | $2.18368 \cdot 10^6$ | 0.99816708175 |
| 2 | 571'903 | 570843 | 0.998146475432 |
| 3 | 241'264 | 240817 | 0,998145823115 |
| 4 | 84'113 | 83957 | 0,998145813478 |
| 5 | 27'497 | 27446 | 0,998145813367 |
| 6 | 8707 | 8691 | 0,998145813366 |
| 7 | 2706 | 2701 | 0,998145813366 |
| 8 | 831 | 829 | 0,998145813366 |
| 9 | 253 | 252 | 0,998145813366 |

10 77 76 8,998L458l3366

d ) We report in eqs. (10) and (11) the theoretical value of electric carge and its relative error :

10) $q_T \doteq 1{,}602176633999 \cdot 10^{-19}$ [Coulomb]

11) $err_q = |e - q_T|/e \simeq 3 \cdot 10^{-16}$

The parameter dl is introduced in order to rescale the relative distances of each charge to the Compton distance .

$$d_l = \frac{\lambda_e}{\lambda_{m_b}} = \frac{q_t}{q_T}$$

3) ENTANGLEMENT OF ORBITAL ANOMALOUS MOMENTS

Considering the effect of the magnetic field's presence in the various orbitals with the reduction of velocities, we can rewrite (1)

12) $L_i = m_i \cdot v_{B_i} \cdot \lambda_{m_i}$

We aim to impose entanglement on the terms $L_i$ through the determination of normalization coefficients.
The sum of the entangled terms constitutes the total orbital anomalous moment $L_T$ :
The parameters defining $L_i$ : $m_i$, $v_{B_i}$, $\lambda_{m_i}$ are themselves dependent on $K_i$: (2)

13) $m_i = \hbar c \cdot K_i$ ; $v_{B_i} = c \cdot \sqrt{2 K_i \cdot x_i^2}$ ; $\lambda_{m_i} = 1/(K_i c^2)$

The most suitable method for calculating the normalization coefficients, in this case, is to use the squared probabilities related to the individual parameters defined on the orbitals themselves, following a variable change to make their probability distributions compatible.

The procedure is as follows:

Let' calculate the derivative with respect a $K_i$ of the (13) :

14) $dm_i/dK_i = \hbar c$ ; $d(v_a \cdot x_i)/dK_i = c \cdot x_i/\sqrt{2K_i}$ ; $d\lambda_{m_i}/dK_i = 1/(c^2 K_i^2)$

we get the probabilities of the individual parameters :

15) $P_{m_i} = P(K_i)/(dm_i/dK_i) = P(K_i)/\hbar c$

16) $P_{v_{B_i}} = \hat{P}(K_i)/(d(v_{a_i} \cdot x_i)/dK_i) = P^*(K_i) \cdot \sqrt{2K_i}/(c \cdot x_i)$

17) $P_{\lambda_{m_i}} = P(K_i)/(d\lambda_{m_i}/dK_i) = P(K_i) \cdot c^2 \cdot K_i^2$

The square of the total probability for each i-th orbital is :

18) $P_{T_i}^2 = P_{m_i}^2 \cdot P_{v_{B_i}}^2 \cdot P_{\lambda_{m_i}}^2 \simeq P^4(K_i) \cdot P^{*2}(K_i) \cdot \frac{2}{\hbar c^2} \cdot \frac{K_i}{c^2 x_i^2} \cdot c^4 K_i^4 = 2 P^4(K_i) \cdot P^{*2}(K_i) \cdot K_i^5/(x_i^2 \cdot \hbar^2)$

We calculate the sum of the squares extended to all orbitals and obtain the normalization constants :

19) $$C_i = \sqrt{\frac{P_{T_i}^2}{\sum_{i=1}^{10} P_{T_i}^2}} = \frac{\sqrt{2}\cdot \hat{P}^2(K_i)\cdot \hat{P}^*(K_i)/\hbar}{\sqrt{2}\cdot \hat{P}^2(K_i)\cdot \hat{P}^*(K_i)/\hbar}\cdot \sqrt{\frac{K_i^5/X_i^2}{\sum_{i=1}^{10} \frac{K_i^5}{X_i^2}}} = \frac{K_i^{2.5}}{X_i} \Big/ \sqrt{\sum_{i=1}^{10} \frac{K_i^5}{X_i^2}}$$

It is immediate to verify that : $\sum_{i=1}^{10} C_i^2 = 1$

## 3) DETERMINATION OF THE MAGNETIC ANOMALY OF THE ELECTRON

Once we have obtained the velocities modified by magnetic fields , we can write the expression for the total orbital anomalous moment :

20) $$L_T = \sum_{i=1}^{10} C_i \cdot m_i V_{B_i} \cdot \lambda_{m_i} \simeq 7{,}683936697336 \cdot 10^{-37} \qquad [J\cdot s]$$

Let's remember the definition of the anomalous magnetic moment :

21) $\mu^{ST} = \frac{e}{m}\cdot \frac{(g-2)}{2}\cdot \hbar$ where :

22) $a_{m_e}^{ST} = (g-2)/2$ it is defined as a standard magnetic anomaly .

Let's define the magnetic anomaly of the proposed model as the ratio : $L_T/h$

23) $$a_{m_e}^{th} \simeq L_T/h$$

For which we have :

24) $\frac{(g-2)}{2} \simeq L_T/h$ so it's immediate :

25) $$\mu^{th} = \frac{e}{m}\cdot \frac{L_T}{2\pi}$$

.

We can calculate the relative error :

26) $$err_{\mu_e} = (a_{m_e}^{ST} - a_{m_e}^{th}) / a_{m_e}^{ST} \simeq 1{,}043 \cdot 10^{-12}$$

This relative error, obtained through the theoretical formulation of the electron's structure and without the use of QED formalism, falls within the order of 10^-12, which confirms the model's extraordinary precision and its full compatibility with experimental data.

## 4) CONCLUSIONS

This paper presents a theoretical framework that allows the calculation of the electron's anomalous magnetic moment from its internal entangled structure alone, without the use of QED techniques. The key aspects of the model are:

The magnetic fields generated by orbital motion influence the local velocities of the associated charges, modifying the anomalous moment.

The normalization of these contributions, due to entanglement, leads to a total orbital anomalous moment.

From this, the theoretical magnetic anomaly is derived with a precision consistent with current experimental data.

This confirms the validity of the entangled model of the electron and opens the path to an equally accurate theoretical determination of the muon's magnetic anomaly, to be addressed in a subsequent paper.

Let's call this type of model : E.E.D.M. (Entangled Electro-Dynamic Model)

## APPENDICES

Examples related to 2nd orbital

Speed calculation of 2nd orbital :

$$K_1 = \alpha^2/2 \simeq 2.662567722 \cdot 10^{-5} \quad ; \quad K_2 = \alpha^{2.5}/2.5 \simeq 1.819589049 \cdot 10^{-6}$$

$$q_1 = e \cdot K_1/K_T \simeq 1.480541717 \cdot 10^{-19} \quad ; \quad q_2 = e \cdot K_2/K_T \simeq 1.011796797 \cdot 10^{-19} \; [\text{Coulomb}]$$

$$m_1 = \hbar \cdot c \cdot K_1 \simeq 8.417779140 \cdot 10^{-31} \quad ; \quad m_2 = \hbar \cdot c \cdot K_2 \simeq 5.752679496 \cdot 10^{-32} \; [\text{Kg}_m]$$

$$\lambda_{m_1} = 1/(c^2 K_1) \simeq 4.178861054 \cdot 10^{-13} \; ; \; \lambda_{m_2} = 1/(c^2 K_2) \simeq 6.114842560 \cdot 10^{-12} \; [m]$$

$$d_1 = q_1/q_T \simeq 0.92408456 \quad ; \quad d_2 = q_2/q_T \simeq 0.06315138$$

$$V_{\alpha_2} = c \cdot \sqrt{2 \cdot K_2} \simeq 571'903 \; [m/s]$$

$$V_{B_2} = V_{\alpha_2} \cdot \sqrt{0.5 \cdot m_2 / \left[0.5 \cdot m_2 + \frac{q_s}{4\pi\varepsilon_0}\left(e - 2(d_1 \cdot q_1 + d_2 \cdot q_2)\right) / \left(4\pi \lambda_{m_2} \cdot c^2/nq\right)\right]} \simeq 570843 \; [m/s]$$

calculation of the 2nd normalization coefficient :

$$\sum_{i=1}^{10} \left(K_i^5 / X_i^2\right) \simeq 1.343066398 \cdot 10^{-23} \quad ; \quad K_2^{2.5}/X_2 \simeq 4.474443295 \cdot 10^{-15}$$

$$C_2 = \frac{K_2^{2.5}}{X_2} \Big/ \sqrt{\sum_{i=1}^{10} \left(K_i^5/X_i^2\right)} \simeq 0.001220928598$$

## REFERENCES


1) Zamboni L. (2024) . A New Paradigm for Quantum Mechanics . viXra 2411.0050 - Quantum Physics

2) Zamboni L. (2024) . Entangled Electron for New Quantum Mechanics  Part 1 . viXra 2412.0092 -  Quantum Physics .
3) Zamboni L. (2025) . Entangled Electron for New Quantum Mechanics  Part 2 . viXra 2503-0010 -  Quantum Physics .
4) CODATA Recomended Value of the Fundamental Physical Constant : 2022 . Retrieved from :    http://physics.nist.gov/constants
5) G.G. Ross , "Grand Unified Theories" , Westview Press (1985) .
6) I.J.R. Aitchinson and A.J.G. Hey ,"Gauge Theories in Particle Physics" , Oxford University Press , Vol. 1  (1982) and Vol. 2  (1983) .
7) Jacson , J.D. , Classical Electrodynamics . Wiley , 1988 .
8) M.E. Peskin and D.V. Scroeder , " An Introduction to Quantum Field Theory" , Addison - Wesley , 1995 .
9) Claude Cohen-Tannoudji , J. Dupont-Roc , G. Grynberg , " Photons and Atoms : Introduction to   Quantum Electrodynamics " , John Wiley & Sons , 1997 .  ISBN 0-471-18433-0
10) John Ellis , M. Karliner , M.A. Samuel , E. Steinfelds , " The Anomalous Magnetic Moments of the  Electron and the Muon -Improved Q.E.D. Prediction Using Pade Approximations " , Physical Review D , Vol. 52 , 1995 , pp.  478 -485 .