

On Anomalous Magnetic Moment of Muon

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Abstract Values of the *magnetic moment of muon*, estimated based on theoretical analysis and experimental observation cum measurement, show an elusive only difference between the two, yet prompting a thorough investigation and analysis looking for a possible solution beyond the Standard Model of particle physics; whereas a fairly close look at the elementary considerations reveals that the *lethargy associated with a bunch of massive muons* interfacing with free space reasons for a rise in the value of the *magnetic permeability of the medium*, which in turn causes a higher value of the magnetic moment in view of the greater extent of magnetization of the muon, while the theoretically estimated value of the magnetic moment assumes a lower level.

Keywords Magnetic moment, Muon, Lethargy

1. Introduction

The present-day anomaly in relation to the *magnetic moment of muon* lies in an almost imperceptible albeit highly delicate variance in evaluation of the magnetic moment of muon by the theoretical computation and through the experimental result. Therefore, we have to find out a simultaneous solution for both the following conundrums:

- One between theory and experiment
- Another within the theory

2. Analysis and Discussion

While the theoretical computation is based on an analytical approach taking into consideration all known possible ways including all parameters and interactions, as applicable, the experimental path is founded on more and more precise and error-free technique and contrivance striving to narrow the gap between the respective outcomes of numerical values. Since years of exercise and hard toil put into both the above ways have resulted in an invariably near-stalemate situation, we are compelled to look into an area where lies the actual solution providing a corrective scenario for both the theory and the experiment together only.

Taking the underlying concepts piecemeal, we may delineate them as follows:

- Magnetic moment is caused by the *strength of magnetization*

- Magnetization is a measure of the *residual flux density* (or *remanence*)

The corresponding relationship may be expressed as ($\mathbf{m} = (\mathbf{1}/\mu_0) * \mathbf{Br} * \mathbf{V}$), where

- (\mathbf{m}) is the magnetic moment (in A.m^2)
- (\mathbf{Br}) is the residual flux density (in Tesla)
- (\mathbf{V}) is the volume of the magnet (in m^3)
- (μ_0) is the permeability of vacuum ($4\pi \times 10^{-7} \text{ H/m}$)

An exhaustive theoretical analysis to compute the value of the magnetic moment (\mathbf{m}) and the most precise experiment to measure the extent of magnetization (\mathbf{Br}) generating the magnetic moment (in each case arriving at the respective g-factor or anomaly-value) still remaining mutually incompatible, we may reasonably expect that yet another factor or parameter should be responsible eventually causing the ultimate anomaly.

3. Finding the Solution

We may note that in the above formula, the value of the *magnetic permeability* has been taken as its corresponding value in free space, whereas in case of the muon having a mass value about two hundred times that of an electron, the overall amount of *lethargy* ($\mathbf{L_e} = \mathbf{m}/\mathbf{c}^2$) [1] associated with a bunch of muons should cause the magnetic permeability value of the medium to be higher than its measure in free space or vacuum.

This critical observation may lead us to substitute (μ_0) by another notation (μ_m) to be the value of the *permeability of the medium*, being numerically higher than its value in free space, in view of *interfacing* of free space and the bunch of muons associated with its lethargy.

Consequently, the real value of the *residual flux density* of muon should be higher than the value corresponding to the *theoretically calculated* value of the magnetic moment, and

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therefore, the *experimentally measured* value of the magnetic moment of muon should also be higher, and the ratio between the two would be equal to the ratio of the magnetic permeability of the medium to that of free space, thus *justifying the observed anomaly*.

It would be an altogether independent exercise to deduce and enumerate from the first principles, the enhanced effect on the magnetic permeability of the medium corresponding to the lethargy due to the mass value of the muon, because of interfacing of the muon with space, so the problem of anomalous magnetic moment of the muon can be rested in perpetuity.

Based on the relationship between luminal-speed in free space and the corresponding values of both permittivity and permeability, we may write an affiliation for the luminal-speed (c_0) and the permittivity (ϵ_0) and permeability (μ_0) in free space as ($1/c_0 = \sqrt{\epsilon_0 \mu_0}$). Now in view of *interfacing due to lethargy of muon mass with free space*, a new medium will be created depicting *higher values of both* permittivity (ϵ_m) and permeability (μ_m) for the medium by the same factor (m_m). Accordingly, the luminal-speed (c_m) for the medium will be lower, giving rise to a **factor for the medium** ($m_m = c_0/c_m$).

Referring to the usual relationship between magnetic moment and g-factor for the muon and taking into account the theoretical value of the g-factor (g_t) as $(-2.002\ 331\ 83620(86))$ and the corresponding experimental value (g_e) as $(-2.002\ 331\ 84121(82))$, as per CODATA, we may estimate the **ratio** (g_e/g_t) equal to 1.0000000025 approximately only.

The effects of interfacing of *lethargy* ($L_e = m/c^2$) and space, for quantum particles of various mass values, causing corresponding decreases in the luminal-speed for the respective scenarios, may be experimentally substantiated and the measure of the factor (m_m) may be determined for each case, and so the desired factor applicable for the muon may be estimated.

We hereby predict that based on experimental measurement of the luminal-speed as cited above, the factor ($m_m = \mu_m/\mu_0$) will be found equal to the ratio (g_e/g_t) and this will eliminate the anomaly under consideration once and for all.

4. Conclusions

Present-day estimates of the magnetic moment of muon, based on the assessment of either the corresponding g-factor or anomaly-value, conducted independently by theory and through the experiment, show a subtle variance between them. However, this arises not out of any hitherto unknown features within or beyond the Standard Model of physics but it may be made to relate to an enhanced value of the magnetic permeability of the medium, caused due to interfacing with free space, of the lethargy of a bunch of massive muons inside space.

This heightened value of magnetic permeability of the medium with respect to its value in free space should be in the range of the ratio between the luminal-speed in free space or vacuum and the corresponding value of the luminal-speed inside muon medium. Experiments may be carried out with various particles having different mass values to determine this ratio, and thereupon to correspond to the mass value of the muon. It is anticipated that this ratio will very nearly approximate the ratio of the g-factor values of the muon from the experimental and the theoretical exertion, thereby resolving the underlying conundrum around the anomaly.

REFERENCES

- [1] Deb, K., A New Look at the Melee of Quantum Particles and Fields available at <http://article.sapub.org/10.5923.j.ijtmp.20231302.01.html>.