Apparent Unsettled Value of the Recently Measured Muon Magnetic Moment

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In this paper, we point out that the anomalous value of the muon magnetic moment recently measured at FERMILAB appears to be unsettled due to the experimentally unresolved behavior of the mean life of muons with speed caused by non-local internal effects as well as the irreversibility of the muon decay.

1 Introduction

In the preceding paper [1], we outlined:

1) Historical and recent verifications of the Einstein-Podolsky-Rosen argument that *"Quantum mechanics is not a complete theory"* (EPR argument) [2];

2) Mathematical, theoretical and experimental foundations of the completion of quantum mechanics into *hadronic mechanics* (hm) for the representation of the extended, thus deformable, and hyperdense hadrons which representation is achieved via the symmetries and physical laws of the completed invariant

$$\hat{x}^{\hat{2}} = \frac{x_1^2}{n_1^2} + \frac{x_2^2}{n_2^2} + \frac{x_3^2}{n_3^2} - t^2 \frac{c^2}{n_4^2}, \quad (1)$$

where $n_k^2 > 0,\ k = 1, 2, 3$ represents the dimension and shape of hadrons normalized to the values $n_k^2 = 1$ for the perfect sphere, and $n_4^2 > 0$ represents the density of hadrons normalized to the value $n_4^2 = 1$ for the vacuum;

3) The representation of *all* characteristics of the muons, including the recently measured difference between the experimental value of the *muon* g-factor, g_μ^{EXP}, and its prediction via quantum electrodynamics, g_μ^{QED},

$$\begin{aligned} & g_\mu^{EXP} - g_\mu^{QED} = \\ & = 2.00233184122 - 2.00233183620 \\ & = 0.00000000502 > 0\,, \end{aligned} \quad (2)$$

which representation is achieved via the hadronic structure model of the muons

$$\mu^\pm = (e_\downarrow^-, e_\uparrow^\pm, e_\downarrow^+)_{hm}\,, \quad (3)$$

with physical constituents produced free in the spontaneous decay with the lowest mode, $\mu^\pm \rightarrow e^- + e^\pm + e^+, \%10^{-12}$, while the presence of an electron-positron pair in the muon structure, which is confirmed by the additional spontaneous decay $\mu^\pm \rightarrow e^\pm + 2\gamma, \%10^{-11}$, allows the understanding of the instability of the muons as well as a numeric representation if its mean life. In particular, thanks to the use of hadronic mechanics, [1] has achieved the following numeric values of the *n*-characteristic quantities of the muons

$$n_1^2 = n_2^2 \approx 0.4926, \quad n_3^2 \approx 0.0149, \quad n_4^2 \approx 0.0149, \quad (4)$$

with the following EPR completion of the muon g-factor

$$\hat{g}_\mu^{EXP} = \frac{n_4}{n_3} g_\mu^{QED}, \quad \frac{n_4}{n_3} = 1.00000000502. \quad (5)$$

In this paper, we use the preceding results to indicate that, despite the accuracy of measurements [6], the anomalous magnetic moment of the muons appears to remain unsettled due to deviations from the relativistic behavior of mean lives of unstable hadrons with speed that are predicted by internal non-local effects, the time irreversibility of spontaneous decays, and other aspects.

2 Apparent unsettled aspects in the muon magnetic moment

To implement due scientific process on anomalous values (2), we should recall P. A. M. Dirac's [7] and other authoritative doubts on the final character of the numeric values obtained from quantum electrodynamics due to the divergence of Feynman's and other series (see [8] for a recent account on QED divergences).

Additionally, measurements [6] have been done via the assumption that the mean life of muons behaves with speed according to the time dilation law of special relativity

$$t = t_o \sqrt{1 - \frac{v^2}{c^2}}\,. \quad (6)$$

The exact validity of the above law for electrons and other *point-like* particles in vacuum can be considered, nowadays, to be beyond scientific doubt.

However, at this writing there exist unresolved aspects in regard to the experimental behavior of law (6) for the behavior of the mean life with speed (or, equivalently, with energy) of *unstable, thus composite particles.*

In 1965, D. I. Blokhintsev [9] pointed out the expected inapplicability (rather than the violation) of special relativity for the interior of hadrons due to non-local effects in their hyperdense structure and suggested that deviations due to internal effects could be measured in the outside via deviations from time dilation law (6).

In 1983, R. M. Santilli [10, 11] (see also notes [12] from lectures delivered in 1991 by Santilli at the ICTP, Trieste, Italy, and Section 8 of the recent update [4]) showed that the axioms of special relativity remain valid for time reversible processes of extended particles with invariant (1) when realized via the use of isomathematics with axiom-preserving EPR completion of law (6)

$$t = t_o \sqrt{1 - \frac{v^2/n_3^2}{c^2/n_4^2}}\,. \tag{7}$$

Additionally, Santilli [13, 14] pointed the inapplicability (rather than the violation) of special relativity and relativistic quantum mechanics for time irreversible processes such as the spontaneous decays, due to the known reversibility of said theories. Its origin was identified in the invariance of Lie's theory under anti-Hermiticity, by therefore suggesting the completion of Lie and Lie-isotopic methods into the broader Lie-admissible methods [16, 17] (see [3] for detailed treatments and [4] for a recent update).

These studies triggered a number of generalizations of time dilation law (6), such as those by L. B. Redei [18], D. Y. Kim [19] and others.

In 1989, A. K. Aringazin [20] proved that all preceding generalizations of law (6) are particular cases of the isotopic law (7) because they can be obtained via different expansions of the latter law in terms of different parameters and with different truncation, thus restricting the experiments to the test of law (7).

In 1983, S. H. Aronson *et al* [21] reported the outcome of experiments conducted at FERMILAB showing apparent *deviations* from law (6) for the $K^0 - \bar{K}^0$ system in the energy range from 0 to 100 GeV.

In 1987, N. Grossman *et al* [22] reported counter-experiments also conducted at FERMILAB showing an apparent *confirmation* of law (6), but in the *different energy range* from 100 to 250 GeV.

In 1992, F. Cardone *et al* [23] indicated that counter-measurements [22] from 100 to 350 GeV leave basically unresolved the deviations of law (6) from 0 to 100 GeV [21], and that the isotopic law (7) provides an exact fit for both measurements [21, 22] (Fig. 1).

Finally, in 1998, Yu. Arestov *et al* [24] pointed out apparent flaws in the theoretical elaboration of the experimental data of measurements [22].

3 Concluding remarks

The above results appear to confirm the lack of exact character of time evolution law (6) for the behavior of the mean life of unstable particles with speed. In fact, under the assumption in first approximation that the muon spontaneous decay is time-reversible, isotopic time dilation law (7) with values (5) predicts the *increase* of anomalous value (2)

$$t = t_o \sqrt{1 - 1.00000000502\,\frac{v^2}{c^2}}\,, \tag{8}$$

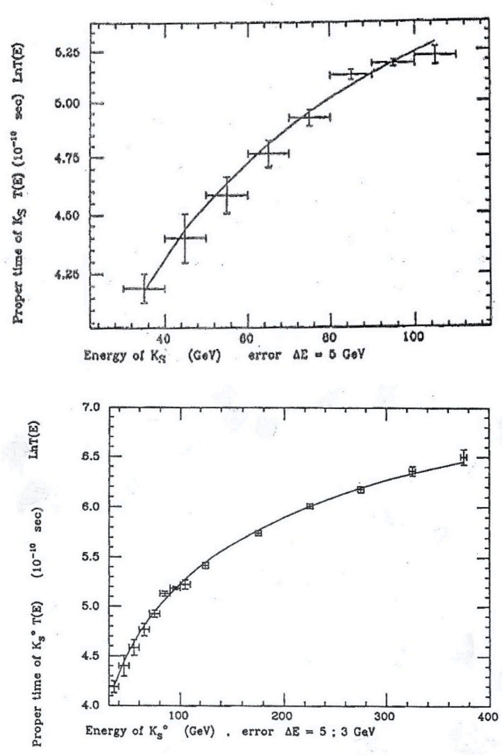

Fig. 1: In this figure, we reproduce the exact fits of isotopic time dilation law (7) obtained by F. Cardone et al [23] of: 1) Deviations [21] from the time dilation law (6) for the behavior of the $K^0 - \bar{K}^0$-system from 0 to 100 GeV (top view); 2) The exact fit of both deviations 0 to 100 GeV [21] and apparent verification in the range from 100 to 350 GeV [22] (bottom view).

with the expectation of bigger deviations for a full time irreversible treatment.

In conclusion, it seems plausible to expect that, in the event deviations [21] from time dilation (6) are confirmed, experimental value (2) of the muon magnetic moment should be correspondently revised.

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