The Final Formulas of the Anomalous Magnetic Moment of Electron, Muon and Tauon

Gang Chen†, Tianman Chen, Tianyi Chen

Guangzhou Huifu Research Institute Co., Ltd., Guangzhou, P. R. China

7-20-4, Greenwich Village, Wangjianglu 1, Chengdu, P. R. China

†Correspondence to: gang137.chen@connect.polyu.hk

Abstract

This paper is a subsequent paper to our previous paper "Concise Formulas of the Anomalous Magnetic Moment of Electron/Muon/Tauon and the Fine-structure Constant" (viXra:2106.0042v5), in which we gave some formulas and values of the anomalous magnetic moment (a=(g-2)/2) of electron, muon and tauon. For example, we calculated the values of the anomalous magnetic moment of muon to be 0.00116592057152 and 0.00116592057075 on June 2021/6/13 and 2023/3/14 respectively, and with 3 less digits they had the same value of 0.00116592057. On 2023/8/10 Fermilab Muon g-2 Collaboration announced their latest measurement of the anomalous magnetic moment of muon to be 0.00116592057(25), which should be perfectly consistent with our calculations or predictions. In this paper, we'll give the final formulas of the anomalous magnetic moment of electron, muon and tauon.

Keywords: the anomalous magnetic moment, electron, muon, tauon, the fine-structure constant, 2π-e formula, Fermilab muon g-2 collaboration, the standard model.

1. Introduction

In our previous paper[1], based on Schwinger's original formula[2] between the anomalous magnetic moment of electron and the fine-structure constant and our formulas such as 2π-e formula and the formulas of the fine-structure constant, we constructed two sets of formulas of the anomalous magnetic moment of electron, muon and tauon as follows.

$2\pi - e$ formula:

$$2\pi = \left(\frac{e}{e^{\gamma_c}}\right)^2 = e^2 \frac{e^2}{(\frac{2}{1})^3} \frac{e^2}{(\frac{3}{2})^5} \frac{e^2}{(\frac{4}{3})^7} \cdots$$

$$(2\pi)_{Chen-k} = \left(\frac{e}{e^{\gamma_{c-k}}}\right)^2 = e^2 \frac{e^2}{(\frac{2}{1})^3} \frac{e^2}{(\frac{3}{2})^5} \frac{e^2}{(\frac{4}{3})^7} \cdots \frac{e^2}{(\frac{k+1}{k})^{2k+1}}$$

Formulas of the fine-structure constant:

$$\alpha_1 = \frac{36}{7\cdot(2\pi)_{Chen-112}} \frac{1}{112+\frac{1}{75^2}} = 1/137.035999037435$$

$$\alpha_2 = \frac{13\cdot(2\pi)_{Chen-278}}{100} \frac{1}{112-\frac{1}{64\cdot 3\cdot 29}} = 1/137.035999111818$$

Formulas of the anomalous magnetic moment of electron, muon and tauon:

Schwinger formula (1947): $a_e \approx \frac{\alpha}{2\pi}$

Set 1:

$$a_e = \frac{\alpha_2\gamma_e}{(2\pi)_{Chen-109}} = \frac{13\cdot(2\pi)_{Chen-278}}{100\cdot(2\pi)_{Chen-109}} \frac{(1+\frac{1}{25\cdot 11\cdot 47\cdot 109})}{112-\frac{1}{64\cdot 3\cdot 29}}$$

$= 0.00115965218134971 \quad (2021/6/6)$

$$a_\mu = \frac{\alpha_2\gamma_\mu}{(2\pi)_{Chen-109}} = \frac{13\cdot(2\pi)_{Chen-278}}{100\cdot(2\pi)_{Chen-109}} \frac{(1+\frac{1}{25\cdot 11\cdot 47\cdot 109})(1+\frac{1}{5\cdot 37})}{112-\frac{1}{64\cdot 3\cdot 29}}$$

$= 0.00116592057152 \quad (2021/6/13)$

$$a_\tau = \frac{\alpha_2\gamma_\tau}{(2\pi)_{Chen-109}} = \frac{13\cdot(2\pi)_{Chen-278}}{100\cdot(2\pi)_{Chen-109}} \frac{(1+\frac{1}{25\cdot 11\cdot 47\cdot 109})(1+\frac{1}{5\cdot 13})}{(112-\frac{1}{64\cdot 3\cdot 29})}$$

$= 0.00117749298414 \quad (2021/6/17)$

Set 2:

$$a_e = \frac{\alpha_2\gamma_e}{(2\pi)_{Chen-109}} = \frac{13(2\pi)_{Chen-278}}{100(2\pi)_{Chen-109}} \frac{1+\frac{1}{3\cdot 47\cdot 73\cdot 137}}{112-\frac{1}{64\cdot 3\cdot 29}}$$

$= 0.00115965218058153 \quad (2023/3/7)$

$$a_\mu = \frac{\alpha_2\gamma_\mu}{(2\pi)_{Chen-109}} = \frac{13\cdot(2\pi)_{Chen-278}}{100\cdot(2\pi)_{Chen-109}} \frac{(1+\frac{1}{3\cdot 47\cdot 73\cdot 137})(1+\frac{1}{5\cdot 37})}{112-\frac{1}{64\cdot 3\cdot 29}}$$

$$= 0.00116592057075 \quad (2023/3/10)$$

$$a_\tau = \frac{\alpha_2\gamma_\tau}{(2\pi)_{Chen-109}} = \frac{13\cdot(2\pi)_{Chen-278}}{100\cdot(2\pi)_{Chen-109}} \frac{(1+\frac{1}{3\cdot 47\cdot 73\cdot 137})(1+\frac{1}{6\cdot 11})}{112-\frac{1}{64\cdot 3\cdot 29}}$$

$$= 0.00117722266817 \quad (2023/3/10)$$

In this paper, we will give a new formula of the anomalous magnetic moment of tauon and determine which one of the above two sets of formulas of the anomalous magnetic moment of electron, muon and tauon is more reasonable and should be the final set.

2. A New Formula of the Anomalous Magnetic Moment of Tauon

Based on the above formulas, we construct a new formula of the anomalous magnetic moment of tauon as follows, and suppose it should be more reasonable.

$$a_\tau = \frac{\alpha_2\gamma_1\gamma_2\gamma_3}{(2\pi)_{Chen-109}} = \frac{13\cdot(2\pi)_{Chen-278}}{100\cdot(2\pi)_{Chen-109}} \frac{(1+\frac{1}{3\cdot 47\cdot 73\cdot 137})(1+\frac{1}{5\cdot 37})(1+\frac{1}{103})}{112-\frac{1}{64\cdot 3\cdot 29}}$$

$$= 0.00117724019 \quad (2023/8/14)$$

3. The Final Formulas of the Anomalous Magnetic Moment of Electron, Muon and Tauon

With the above stated more reasonable formula of the anomalous magnetic moment of tauon, the final formulas of the anomalous magnetic moment of electron, muon and tauon were determined and listed along with their related formulas as follows. And their reasonability could be confirmed by their relationships with nuclides[1, 3-11].

$2\pi - e$ formula:

$$2\pi = (\frac{e}{e^{\gamma_c}})^2 = e^2 \frac{e^2}{(\frac{2}{1})^3} \frac{e^2}{(\frac{3}{2})^5} \frac{e^2}{(\frac{4}{3})^7} \cdots$$

$$(2\pi)_{Chen-k} = (\frac{e}{e^{\gamma_{c-k}}})^2 = e^2 \frac{e^2}{(\frac{2}{1})^3} \frac{e^2}{(\frac{3}{2})^5} \frac{e^2}{(\frac{4}{3})^7} \cdots \frac{e^2}{(\frac{k+1}{k})^{2k+1}}$$

Formulas of the fine-structure constant:

$$\alpha_1 = \frac{36}{7\cdot(2\pi)_{Chen-112}} \frac{1}{112+\frac{1}{75^2}} = 1/137.035999037435$$

$$\alpha_2 = \frac{13\cdot(2\pi)_{Chen-278}}{100} \frac{1}{112-\frac{1}{64\cdot 3\cdot 29}} = 1/137.035999111818$$

Formulas of the speed of light in atomic units

$$c_{au} = \frac{c}{v_e} = \frac{1}{\alpha_c} = \frac{1}{\sqrt{\alpha_1\alpha_2}}$$

$$= \sqrt{112\times(168-\frac{1}{3}+\frac{1}{12\cdot 47}-\frac{1}{14\cdot 112\cdot(2\cdot 173+1)})} = 137.035999074626$$

Formulas of the anomalous magnetic moment of electron, muon and tauon:

Schwinger formula (1947): $a_e \approx \dfrac{\alpha}{2\pi}$

$$a_e = \frac{\alpha_2\gamma_1}{(2\pi)_{Chen-109}} = \frac{13(2\pi)_{Chen-278}}{100(2\pi)_{Chen-109}} \frac{1+\frac{1}{3\cdot 47\cdot 73\cdot 137}}{112-\frac{1}{64\cdot 3\cdot 29}}$$

$= 0.00115965218058153 \quad (2021/6/6,\ 2023/3/7)$

$$a_\mu = \frac{\alpha_2\gamma_1\gamma_2}{(2\pi)_{Chen-109}} = \frac{13(2\pi)_{Chen-278}}{100(2\pi)_{Chen-109}} \frac{(1+\frac{1}{3\cdot 47\cdot 73\cdot 137})(1+\frac{1}{5\cdot 37})}{112-\frac{1}{64\cdot 3\cdot 29}}$$

$= 0.00116592057 \quad (2021/6/13,\ 2023/3/10)$

$$a_\tau = \frac{\alpha_2\gamma_1\gamma_2\gamma_3}{(2\pi)_{Chen-109}} = \frac{13(2\pi)_{Chen-278}}{100(2\pi)_{Chen-109}} \frac{(1+\frac{1}{3\cdot 47\cdot 73\cdot 137})(1+\frac{1}{5\cdot 37})(1+\frac{1}{103})}{112-\frac{1}{64\cdot 3\cdot 29}}$$

$= 0.00117724019 \quad (2021/6/17,\ 2023/3/10,\ 2023/8/14)$

Other formulas such as:

$141+173=314,\ 141=3\cdot 47,\ 314=2\cdot 157,\ 68=136/2,\ 69=138/2,\ \cdots$

Relationships of the above formulas with nuclides:

${}^{14,15}_{7}N_{7,8}$ ${}^{27}_{13}Al_{14}$ ${}^{28-30}_{14}Si_{14-16}$ ${}^{47,48,50}_{22}Ti_{25,26,28}$ ${}^{54,56,58}_{26}Fe_{28,30,32}$ ${}^{58,60,64}_{28}Ni_{30,32,36}$ ${}^{63,65}_{29}Cu_{34,36}$

${}^{73,74}_{32}Ge_{41,42}$ ${}^{82,83,84}_{36}Kr_{46,47,48}$ ${}^{85,87}_{37}Rb_{48,50}$ ${}^{100}_{44}Ru_{56}$ ${}^{103}_{45}Rh_{58}$ ${}^{107,109}_{47}Ag_{60,62}$ ${}^{111,112}_{48}Cd_{63,64}$

${}^{112,114,116,118,119,120}_{50}Sn_{62,64,66,68,69,70}$ ${}^{125,126}_{52}Te_{73,74}$ ${}^{136,137,138}_{56}Ba_{80,81,82}$ ${}^{140,142}_{58}Ce_{82,84}$ ${}^{141}_{59}\mathrm{Pr}_{82}$

${}^{145,146}_{61}Pm^{*}_{84,85}$ ${}^{157,158}_{64}Gd_{93,94}$ ${}^{168}_{68}Er_{100}$ ${}^{169}_{69}Tm_{100}$ ${}^{173}_{70}Yb_{103}$ ${}^{180,181}_{73}Ta_{107,108}$ ${}^{182-184,186}_{74}W_{108-110,112}$

${}^{5\cdot 37,187}_{75}\mathrm{Re}_{110,112}$ ${}^{4\cdot 47,192}_{76}Os_{112,116}$ ${}^{208}_{82}Pt_{126}$ ${}^{209}_{83}Bi^{*}_{126}$ ${}^{209}_{84}Po^{*}_{125}$ ${}^{210,211}_{85}At^{*}_{125,126}$ ${}^{222}_{86}Rn^{*}_{136}$

${}^{223,224}_{87}Fr^{*}_{136,137}$ ${}^{226}_{88}Ra^{*}_{138}$ ${}^{227}_{89}Ac^{*}_{138}$ ${}^{8\cdot 29}_{90}Th^{*}_{142}$ ${}^{231,8\cdot 29}_{91}Pa^{*}_{140,141}$ ${}^{235,238}_{92}U^{*}_{143,146}$ ${}^{239,240}_{94}Pu^{*}_{145,146}$

$^{257}_{100}Fm^{*}_{157}$ $^{264,265}_{103}Lr^{*}_{161,162}$ $^{274}_{107}Bh^{*}_{167}$ $^{276}_{108}Hs^{*}_{168}$ $^{278}_{109}Mt^{*}_{169}$ $^{285}_{112}Cn^{*}_{173}$ $^{310,312}_{125}Ch^{ie}_{185,187}$ $^{2\cdot157}_{126}Ch^{ie}_{56}$

$^{344,2\cdot173,12\cdot29}_{136,137,138}Fy^{ie}_{208,209,210}$ $^{354}_{141}Ch^{ie}_{213}$ $^{370}_{146}Ch^{ie}_{224}$ $^{400}_{157}Ch^{ie}_{243}$ $^{420}_{168}Ch^{ie}_{252}$ $^{426}_{169}Ch^{ie}_{257}$ $^{437,6\cdot73}_{173}Ch^{ie}_{264,265}$

4. Comparison of Theoretically Calculated and Experimentally Measured a_e, a_μ and a_τ

With the values given by the above final formulas and the theoretical and experimental values reported in literatures, we give their comparison in **Table 1**.

Table 1. Comparison of Theoretically Calculated and Experimentally Measured a_e, a_μ and a_τ.

Lepton	Calculated a^{SM} By Standard Model	Calculated a^{TC} By Theory of Chirality	Measured a^{EXP} By Experiment	$(a^{SM}-a^{TC})/a^{TC}$
e	0.001159652181606(23)[12]	0.00115965218058153	0.00115965218059(13)[13]	8.8×10^{-10}
μ	0.00116591810(43)[14]	0.00116592057	0.00116592057(25)[15]	-2.1×10^{-6}
τ	0.00117721(5)[16]	0.00117724019	-0.052–0.013[17]	-2.6×10^{-5}

Note: Lifetime of tauon is very short, so it is quite difficult to measure a_τ with ordinary spin precession experiments[17].

In **Table 1**, the calculated value of the anomalous magnetic moment of muon by our theory (Theory of Chirality[6]) was 0.00116590057 (2021/6/13 and 2023/3/10), and it was perfectly consistent with the measurement result announced by Fermilab Muon g-2 Collaboration on 2023/8/10 which was 0.00116590057(25) based on the data from their experiment Run-2/3.

5. Prediction to Fermilab's Result Based on the Data from it Experiment Run-4

Based on our formulas and calculations, we here give prediction to Fermilab's result based on the data from its experiment Run-4 which should be announced in 2025. The result would be very closed to 0.00116590057(12).

By the way, we predict that the standard model of particle physics should be complete because our theory of chirality is an alternative theory to the standard model to calculate the anomalous magnetic moment of electron, muon and tauon.

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Acknowledgements

Huibei Huifu Nanometer Material Co., Ltd. and Guangzhou Huifu Research Institute Co., Ltd. have been giving Dr. Gang Chen a part-time employment since Dec. 2018. Thank these companies for their financial support. Specially thank Dr. Yuelin Wang and other colleagues of these companies for their appreciation, support and help.

Appendix I: Research History

Section	Page	Date	Location
Preparing this paper (v1)	6	2023/8/25-26	Hanyuan, Sichuan

Note: Date was recorded according to Beijing Time.