Anomalous magnetic moment and Higgs coupling of the muon in a sequential U(1) gauge model with dark matter

Rathin Adhikari,[1,*] Imtiyaz Ahmad Bhat,[1,†] Debasish Borah,[2,‡] Ernest Ma,[3,§] and Dibyendu Nanda[4,∥]

[1]*Centre for Theoretical Physics, Jamia Millia Islamia-Central University, Jamia Nagar, New Delhi-110025, India*

[2]*Department of Physics, Indian Institute of Technology, Guwahati, Assam 781039, India*

[3]*Department of Physics and Astronomy, University of California, Riverside, California 92521, USA*

[4]*School of Physical Sciences, Indian Association for the Cultivation of Science, 2A & 2B Raja S. C. Mullick Road, Kolkata 700032, India*

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We study an Abelian gauge extension of the standard model with fermion families having nonuniversal gauge charges. The gauge charges and scalar content are chosen in such an anomaly-free way that only the third generation fermions receive Dirac masses via renormalizable couplings with the Higgs boson. Incorporating additional vectorlike fermions and scalars with appropriate $U(1)$ charges can lead to radiative Dirac masses of first two generations with neutral fermions going in the loop being dark matter candidates. Focusing on radiative muon mass, we constrain the model from the requirement of satisfying muon mass, recently measured muon anomalous magnetic moment by the E989 experiment at Fermilab, along with other experimental bounds including the large hadron collider (LHC) limits. The anomalous Higgs coupling to muon is constrained from the LHC measurements of Higgs to dimuon decay. The singlet fermion dark matter phenomenology is discussed showing the importance of both annihilation and coannihilation effects. Incorporating all bounds lead to a constrained parameter space which can be probed at different experiments.

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I. INTRODUCTION

Recently, the E989 experiment at Fermilab has measured the anomalous magnetic moment (AMM) of a muon, $a_\mu = (g-2)_\mu/2$, showing a discrepancy with respect to the theoretical prediction of the Standard Model (SM) [1]

$$a_\mu^{\rm FNAL} = 116592040(54) \times 10^{-11} \tag{1}$$

$$a_\mu^{\rm SM} = 116591810(43) \times 10^{-11}. \tag{2}$$

When combined with the previous Brookhaven determination

$$a_\mu^{\rm BNL} = 116592089(63) \times 10^{-11}, \tag{3}$$

it leads to a 4.2σ observed excess of $\Delta a_\mu = 251(59) \times 10^{-11}$.[1] The theoretical status of SM calculation of muon AMM can be found in [6]. While this anomaly is known for a long time since the Brookhaven measurements [7], the recent Fermilab measurements have also led to several recent works on updating possible theoretical models with new data, a comprehensive review of which may be found in [8]. Earlier reviews on this topic can be found in [9,10].

In this work, we consider an anomaly free $U(1)_X$ gauge extension of the SM where the first two generations of charged fermions acquire masses only at radiative level. While triangle anomalies cancel due to the addition of chiral fermion triplets, giving rise to type III seesaw origin of light neutrino masses, the new fields introduced for radiative charged fermion masses can also serve as a stable dark matter (DM) candidate, if it is stable and neutral. Focusing primarily on radiative muon mass and muon

*rathin@ctp-jamia.res.in
†imtiyaz@ctp-jamia.res.in
‡dborah@iitg.ac.in
§ma@physastro.ucr.edu
∥psdn2502@iacs.res.in

[1]It should however, be noted that the latest lattice results [2] predict a larger value of muon $(g-2)$ bringing it closer to experimental value. Tension of the measured muon $(g-2)$ with global electroweak fits from e^+e^- to hadron data was also reported in [3–5].